MOTOROLA
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# Introduction to Broadband Networks

## Training Manual

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# Contents


## Introduction

**Audience** ..... i
**Objectives** ..... i
**Materials** ..... i
**Agenda** ..... ii

## Section 1 Broadband Communications Industry

**The History of Cable Television** ..... 1-2
The 1940s and 1950s ..... 1-2
The 1960s ..... 1-3
The 1970s ..... 1-5
The 1980s ..... 1-6
The 1990s ..... 1-8
2000 and Beyond ..... 1-9
**Top 10 MSOs** ..... 1-10
**Top 10 Cable Networks** ..... 1-10

## Section 2 What is TV?

**Radio Waves** ..... 2-2
**Amplitude Modulation** ..... 2-3
**Frequency Modulation** ..... 2-4
**Scanning** ..... 2-5

## Section 3 Bandwidth

**Current Model** ..... 3-2

## Section 4 Headend

**Cable System (Broadband Communications Network)** ..... 4-2
**Signal Collection** ..... 4-3
**Headend Components** ..... 4-4
Signal Collectors ..... 4-4
Distribution System Access/Multiplexing ..... 4-4
Signal Processors/Network Control ..... 4-4
**Satellite Transmission** ..... 4-6
Satellite Signals Converted to RF ..... 4-7
Analog Receiver Descrambler ..... 4-8

RF Modulator ..... 4-10
**Review** ..... 4-13
**Broadcast TV Transmission** ..... 4-14
Log-Periodic Antenna ..... 4-14
Yagi Antenna ..... 4-14
Heterodyne Processor ..... 4-15
**Off-Air Television Channels** ..... 4-17
**Review** ..... 4-20
**Headend Signal Processing** ..... 4-21
**Broadband Fiber-Optic Transmission** ..... 4-24
**Review** ..... 4-26

## Section 5 Distribution

**Distribution System Components** ..... 5-2
**Fiber Node** ..... 5-3
**Power Supply** ..... 5-3
**Signal Transportation** ..... 5-4
Coaxial Cables ..... 5-4
Classes of Coaxial Cable ..... 5-4
Impedance ..... 5-5
Direct Current ..... 5-6
Alternating Current ..... 5-7
Cable Loss Ratio ..... 5-7
Impedance ..... 5-8
**Passive Devices** ..... 5-8
Line Splitters/Couplers ..... 5-8
Taps ..... 5-11
**Amplifiers** ..... 5-13
Amplifier Processing ..... 5-15
Automatic Gain Control ..... 5-16
Broadband Telecommunications Amplifier ..... 5-16
**Review** ..... 5-18

## Section 6 Customer Premises

**Customer Premises Components** ..... 6-2
Premises Distribution ..... 6-2
User Equipment ..... 6-2
Network Access ..... 6-3
**Customer Drop Cable** ..... 6-3
**House Splitter** ..... 6-4
**Plain Converters** ..... 6-4
**Addressable Converters** ..... 6-4
Addressable Services ..... 6-6
**FM Splitter** ..... 6-7

**Music Choice** ..... 6-8
**Review** ..... 6-9

## Section 7 Network Architecture

**Tree and Branch** ..... 7-2
**Fiber Backbone** ..... 7-3
**Hybrid Fiber Coax (HFC)** ..... 7-4

## Section 8 Evolution to Digital

**What is a Digital Signal** ..... 8-2
**Binary Numbers** ..... 8-2
Exercise ..... 8-3
**Digital Video** ..... 8-4
Analog to Digital Conversion ..... 8-4
Sampling ..... 8-4
Quantizing ..... 8-4
**MPEG-2** ..... 8-5
Overview ..... 8-5
Video ..... 8-5
Transport ..... 8-5
**Digital Signal Processing** ..... 8-6
Integrated Transport Encryption Multiplexer, ITEM 1000 ..... 8-6
Digital Modulator, IM 1000 ..... 8-7
Frequency-Agile Dual-Channel Upconverter, C6U ..... 8-8
**Satellite Signal Processing** ..... 8-8
Integrated Receiver Transcoder, IRT 1000 ..... 8-9
Out-of-Band Modulator, OM 1000 ..... 8-9
Return Path Demodulator, RPD 1000 ..... 8-10
**Digital Video Delivery to the Home** ..... 8-10
Quadrature Amplitude Modulation (QAM) ..... 8-10
Advantages of QAM ..... 8-10
Forward Error Correction ..... 8-11
DCT1000 ..... 8-11
**Standards** ..... 8-11
The Motorola Digital TV system ..... 8-11
Major Digital Standards Efforts ..... 8-12
**Review** ..... 8-13

## Section 9 Alternative Digital Technologies

**Direct Broadcast Satellite** ..... 9-2
**Wireless Systems** ..... 9-2
Multichannel Multipoint Distribution System (MMDS) ..... 9-3
Local Multipoint Distribution System (LMDS) ..... 9-4

Satellite Master Antenna System (SMATV) ..... 9-5

## Glossary

**Acronym List** ..... 1
**Definition of Terms** ..... 9

# Introduction

Please take a few moments to fill out the Registration Form.

## Audience

This course was developed for non-technical industry personnel seeking foundation knowledge of the telecommunications industry.

## Objectives

This one-day course includes a high level overview of the broadband communications network with emphasis on term definition and component functionality. Topics include digital headend equipment, distribution plant equipment, and customer premise equipment. Interactive discussion will address architectures, bandwidth requirements, and system performance standards.

## Materials

During the course, you will be given the following materials:

- Participant Registration Form
- Introduction to Broadband Networks Training Manual
- Various handouts
- Training Course Evaluation Form
- Course Completion Certificate

# Agenda

The duration for this course is one day. Note that the training materials are being continuously updated and improved, therefore this agenda is subject to change.

| Topic |
| --- |
| **Registration/Introduction/Agenda Review** |
| **Section 1 Broadband Communications Industry** |
| **Section 2 What is TV?** |
| **Section 3 Bandwidth** |
| **Section 4 Headend** |
| **Section 5 Distribution** |
| **Section 6 Customer Premises** |
| **Section 7 Network Architecture** |
| **Section 8 Evolution to Digital** |
| **Section 9 Alternative Digital Technologies** |
| **Review/Questions and Answers** |

Section 1

# Broadband Communications Industry

After completing this section of the course, you will be able to:

- ❒ Identify the multiple system operators.
- ❒ Understand the TELCO entry into broadband communications.
- ❒ Identify programming sources

# The History of Cable Television

## The 1940s and 1950s

Cable television originated in 1948 as a service to households in mountainous or geographically remote areas where reception of over-the-air television signals was poor. Antennas were erected on mountain tops or other high points, and homes were wired and connected to these towers to receive the broadcast signals.

By 1950, 70 cable systems served 14,000 subscribers nationwide.

In the late 1950s, when cable operators began to take advantage of their ability to pick up broadcast signals from hundreds of miles away, access to these "distant signals" changed the focus of cable's role from one of transmitting local broadcast signals to one of providing new programming choices.

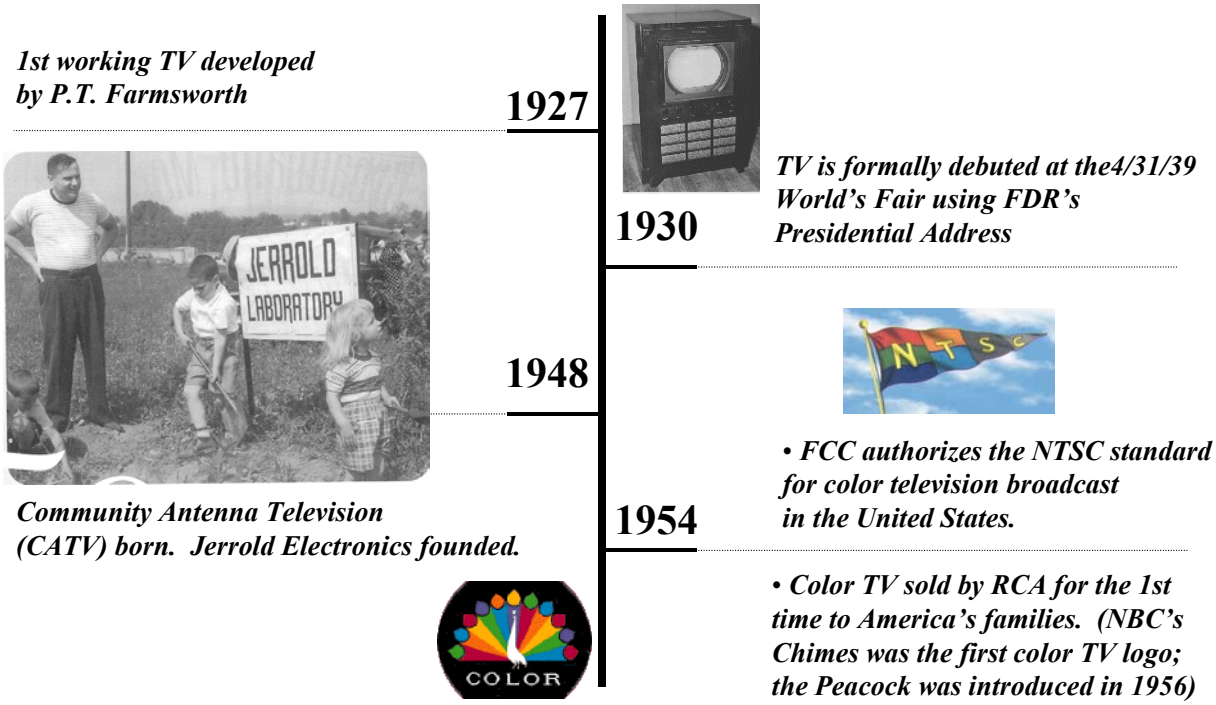

1st working TV developed by P.T. Farmsworth
1927
1930
TV is formally debuted at the4/31/39 World's Fair using FDR's Presidential Address
JERROLD LABORATORY
1948
Community Antenna Television (CATV) born. Jerrold Electronics founded.
N T S C
• FCC authorizes the NTSC standard for color television broadcast in the United States.
1954
COLOR
• Color TV sold by RCA for the 1st time to America's families. (NBC's Chimes was the first color TV logo; the Peacock was introduced in 1956)

**Figure 1-1 CATV, 1927 - 1954**

## The 1960s

By 1962, almost 800 cable systems serving 850,000 subscribers were in business.

Not surprisingly, the growth of cable through the importation of distant signals was viewed as competition by local television stations. In response to broadcast industry concerns, the FCC expanded its jurisdiction and placed restrictions on the ability of cable systems to import distant television signals. This action had the effect of freezing the development of cable systems in major markets.

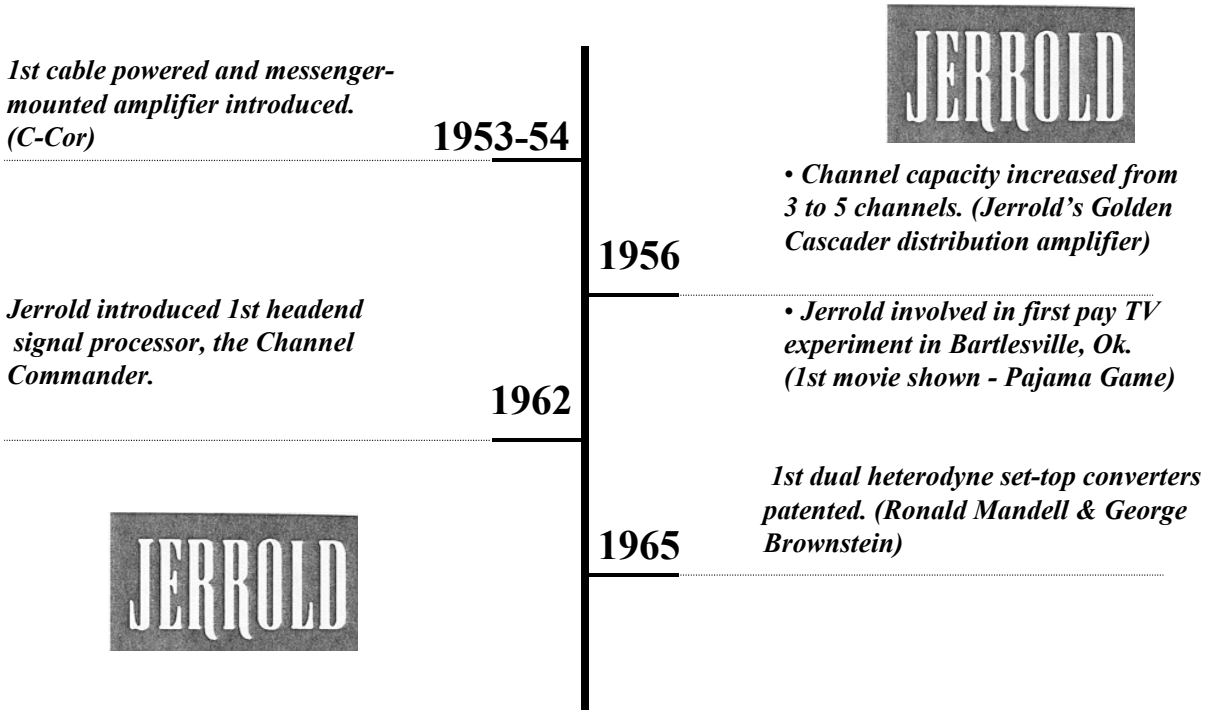

1st cable powered and messenger-mounted amplifier introduced. (C-Cor)
1953-54
JERROLD
• Channel capacity increased from 3 to 5 channels. (Jerrold's Golden Cascader distribution amplifier)
1956
Jerrold introduced 1st headend signal processor, the Channel Commander.
• Jerrold involved in first pay TV experiment in Bartlesville, Ok. (1st movie shown - Pajama Game)
1962
1st dual heterodyne set-top converters patented. (Ronald Mandell & George Brownstein)
JERROLD
1965

**Figure 1-2 CATV, 1953 - 1965**

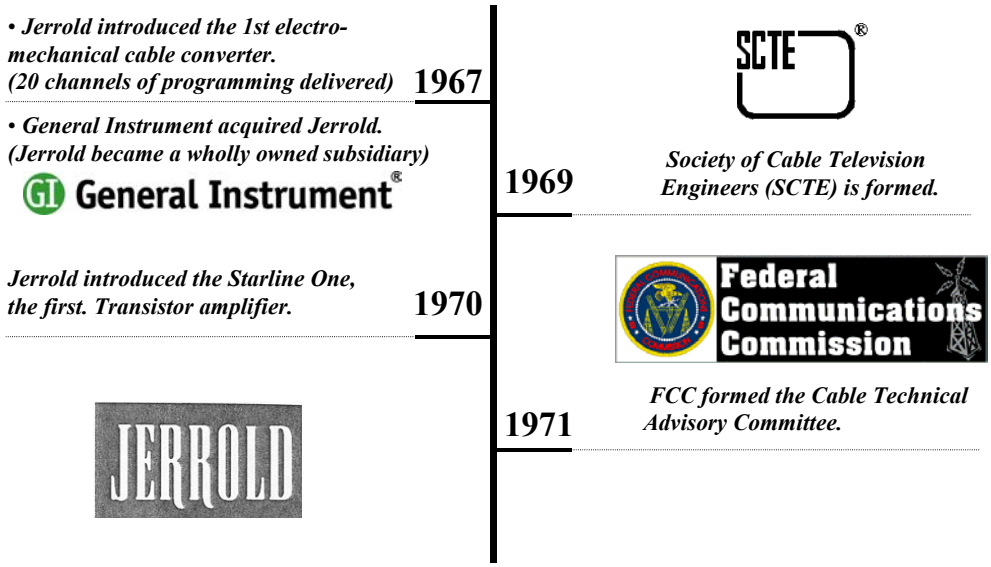

• Jerrold introduced the 1st electro-mechanical cable converter. (20 channels of programming delivered)
1967
• General Instrument acquired Jerrold. (Jerrold became a wholly owned subsidiary)
General Instrument
1969
Society of Cable Television Engineers (SCTE) is formed.
Jerrold introduced the Starline One, the first. Transistor amplifier.
1970
Federal Communications Commission
JERROLD
1971
FCC formed the Cable Technical Advisory Committee.

**Figure 1-3 CATV, 1967 to 1971**

## The 1970s

In the early 1970s, the FCC continued its restrictive policies by enacting regulations that limited the ability of cable operators to offer movies, sporting events, and syndicated programming.

The freeze on cable's development lasted until 1972, when a policy of gradual cable deregulation led to, among other things, modified restrictions on the importation of distant signals.

Throughout the 1970s, concerted industry efforts at the federal, state, and local levels resulted in the continued lessening of cable restrictions. These changes, coupled with cable's pioneering of satellite communications technology, led to a pronounced growth of services to consumers and a substantial increase in cable subscribers.

In 1972, Charles Dolan and Gerald Levin of Sterling Manhattan Cable launched the nation's first pay-TV network -- Home Box Office (HBO). This venture led to the creation of a national satellite distribution system that used a newly approved domestic satellite transmission. Satellites changed the business dramatically, paving the way for the explosive growth of program networks.

The second service to use the satellite was a local television station in Atlanta that broadcast primarily sports and classic movies. The station, owned by R. E. "Ted" Turner, substituted its existing microwave distribution with satellite distribution, and soon became known as the first "superstation," WTBS.

By the end of the decade, nearly 15 million households were cable subscribers.

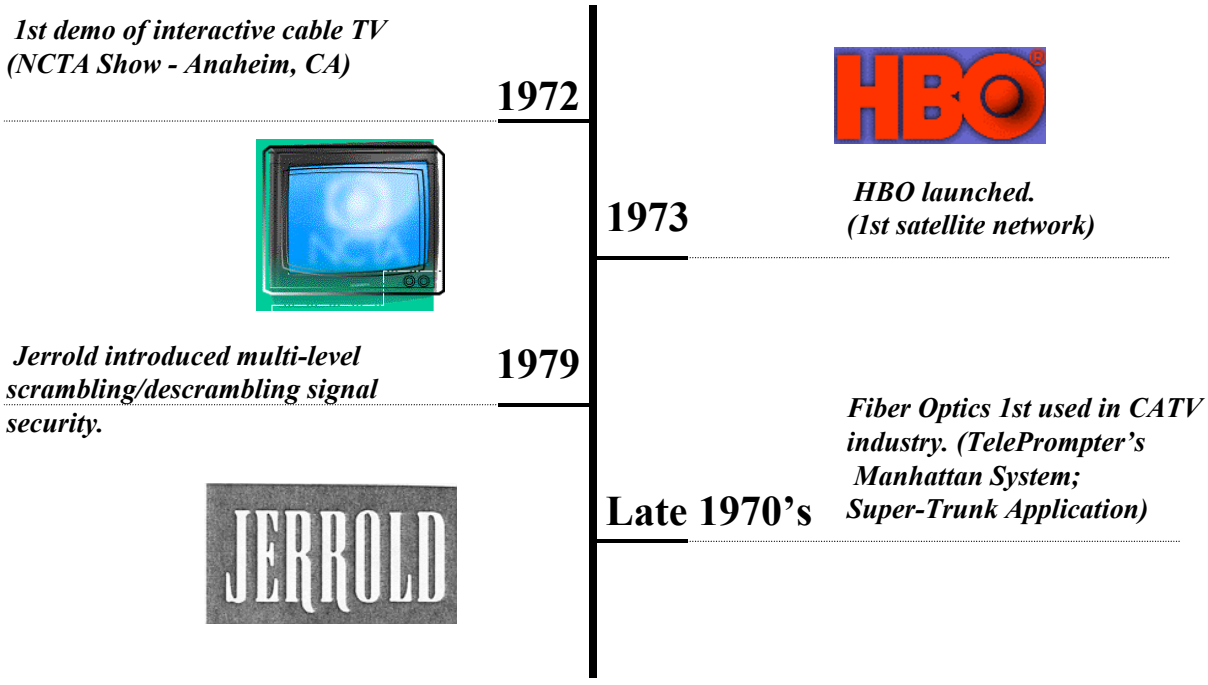



**Figure 1-4 CATV, 1972 to 1979**

## The 1980s

While the delivery of programming via satellite was evolving, the 1984 Cable Act effectively deregulated the industry, stimulating investment in cable plant and programming on an unprecedented level.

There can be little doubt that deregulation had a strong positive effect on the rapid growth of these cable services. From 1984 through 1992, the industry spent more than $15 billion on the wiring of America and billions more on program development. This was the largest private construction project since World War II.

By the end of the decade, nearly 53 million households subscribed to cable, and cable program networks had increased from 28 in 1980 to 74 by 1989.

Satellite delivery, combined with the federal government's relaxation of cable's restrictive regulatory structure, allowed the cable industry to become a major force in providing high-quality video entertainment and information to consumers.

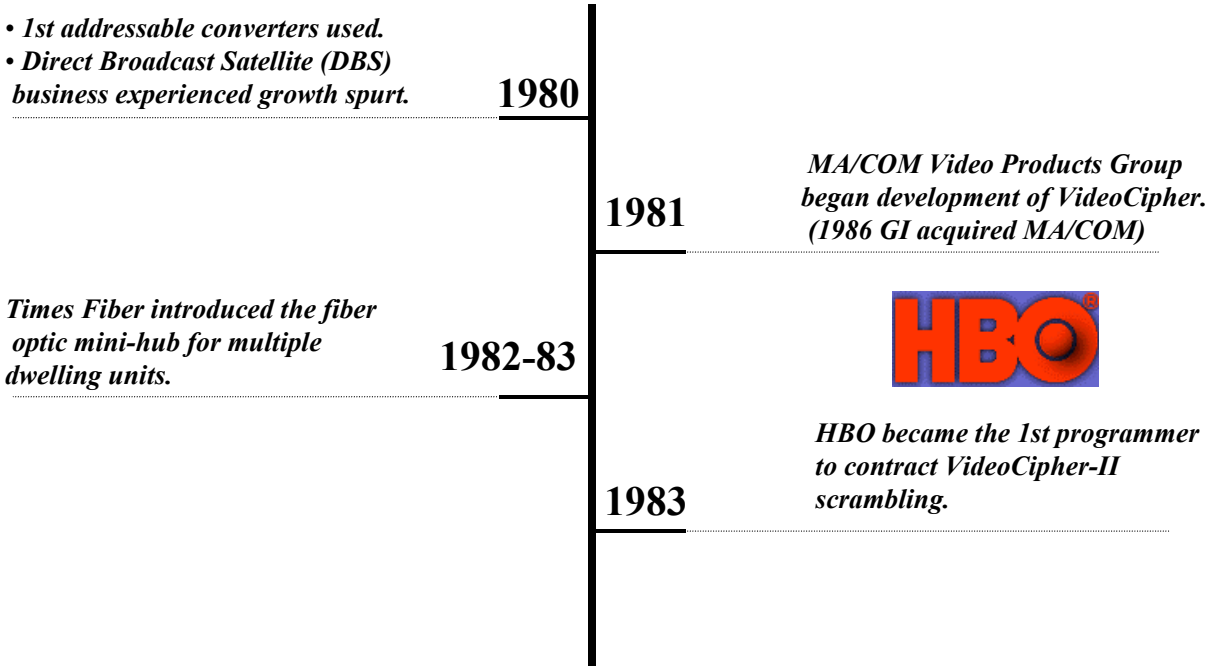

• 1st addressable converters used.
• Direct Broadcast Satellite (DBS) business experienced growth spurt.
1980
1981
MA/COM Video Products Group began development of VideoCipher. (1986 GI acquired MA/COM)
Times Fiber introduced the fiber optic mini-hub for multiple dwelling units.
1982-83
HBO
HBO became the 1st programmer to contract VideoCipher-II scrambling.
1983

**Figure 1-5 CATV, 1980 to 1983**

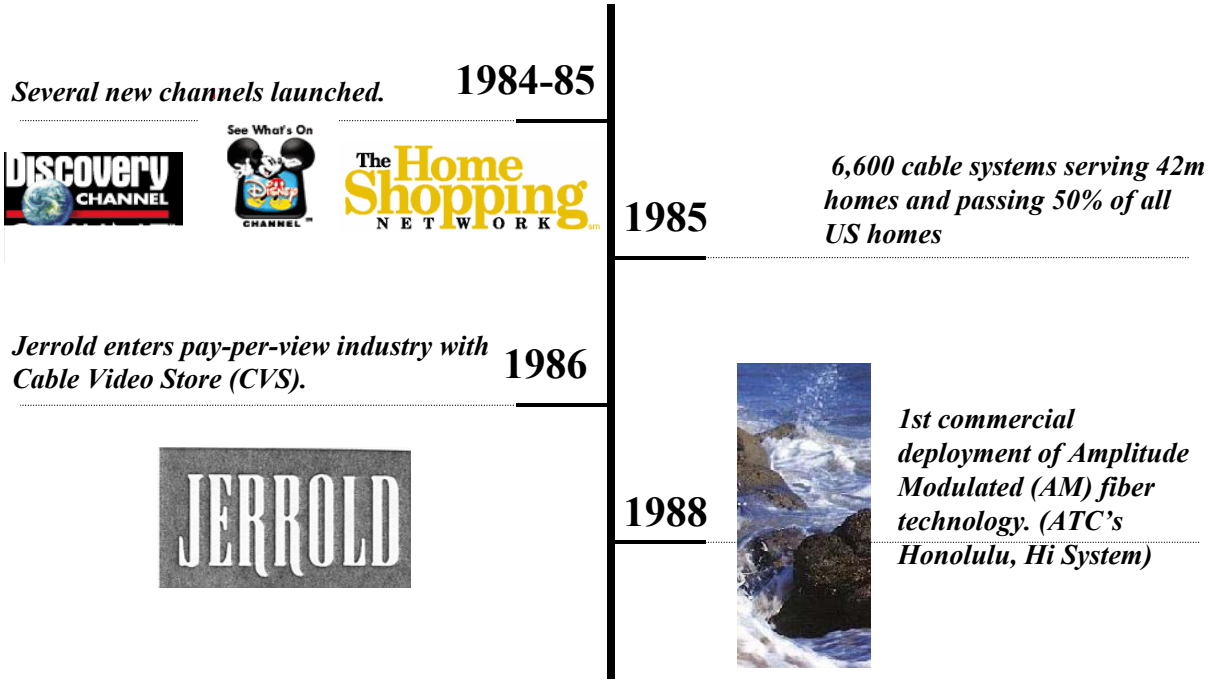

Several new channels launched.
1984-85
Discovery Channel
See What's On
Disney Channel
The Home Shopping Network
1985
6,600 cable systems serving 42m homes and passing 50% of all US homes
Jerrold enters pay-per-view industry with Cable Video Store (CVS).
1986
JERROLD
1988
1st commercial deployment of Amplitude Modulated (AM) fiber technology. (ATC's Honolulu, Hi System)

**Figure 1-6 CATV, 1984 to 1988**

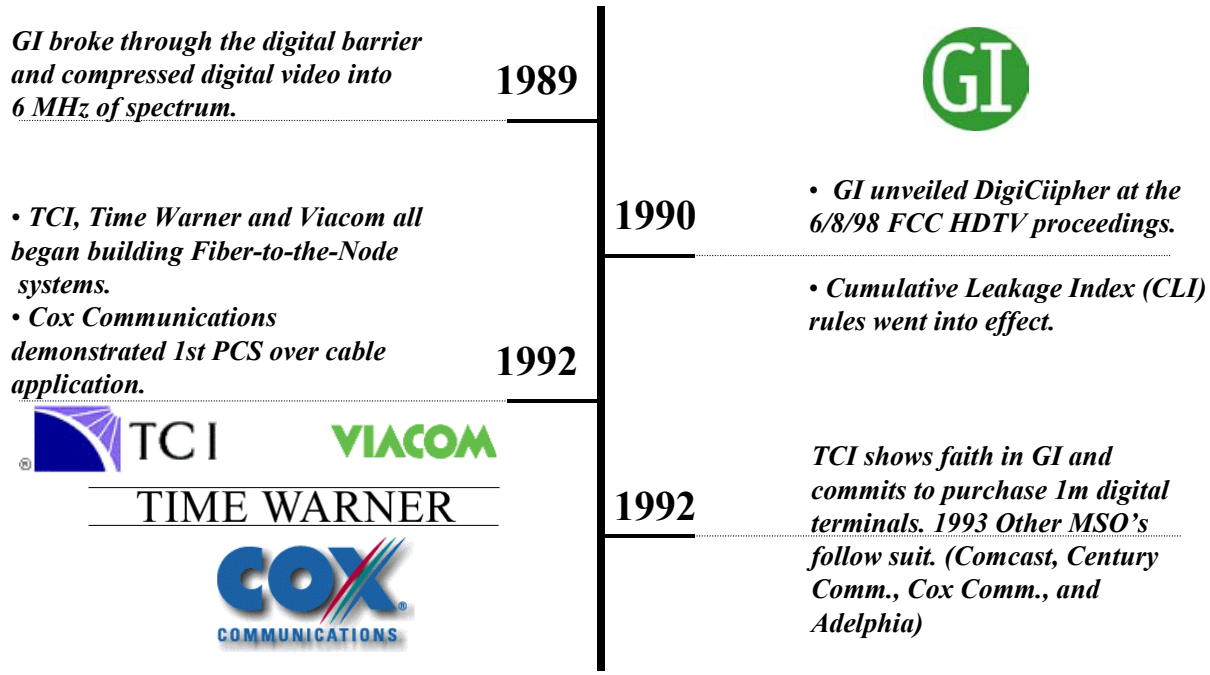

GI broke through the digital barrier and compressed digital video into 6 MHz of spectrum.
1989
GI
• GI unveiled DigiCiipher at the 6/8/98 FCC HDTV proceedings.
1990
• TCI, Time Warner and Viacom all began building Fiber-to-the-Node systems.
• Cox Communications demonstrated 1st PCS over cable application.
1992
• Cumulative Leakage Index (CLI) rules went into effect.
TCI
VIACOM
TIME WARNER
COX COMMUNICATIONS
1992
TCI shows faith in GI and commits to purchase 1m digital terminals. 1993 Other MSO's follow suit. (Comcast, Century Comm., Cox Comm., and Adelphia)

**Figure 1-7 CATV, 1989 to 1992**

## The 1990s

Based on the alternative idea of targeting programming to a specific “niche audience” the number of cable program networks exploded. By the end of 1995, there were 139 cable programming services available nationwide, in addition to many regional programming networks. By the spring of 1998, the number of national cable video networks grew to 171.

Approximately 7 in 10 television households, more than 65 million households, have chosen to subscribe to cable. In 1998, the average subscriber can choose from a wide selection of quality programming, with over 57% of all subscribers receiving 54 channels or more, up from 47 in 1996.

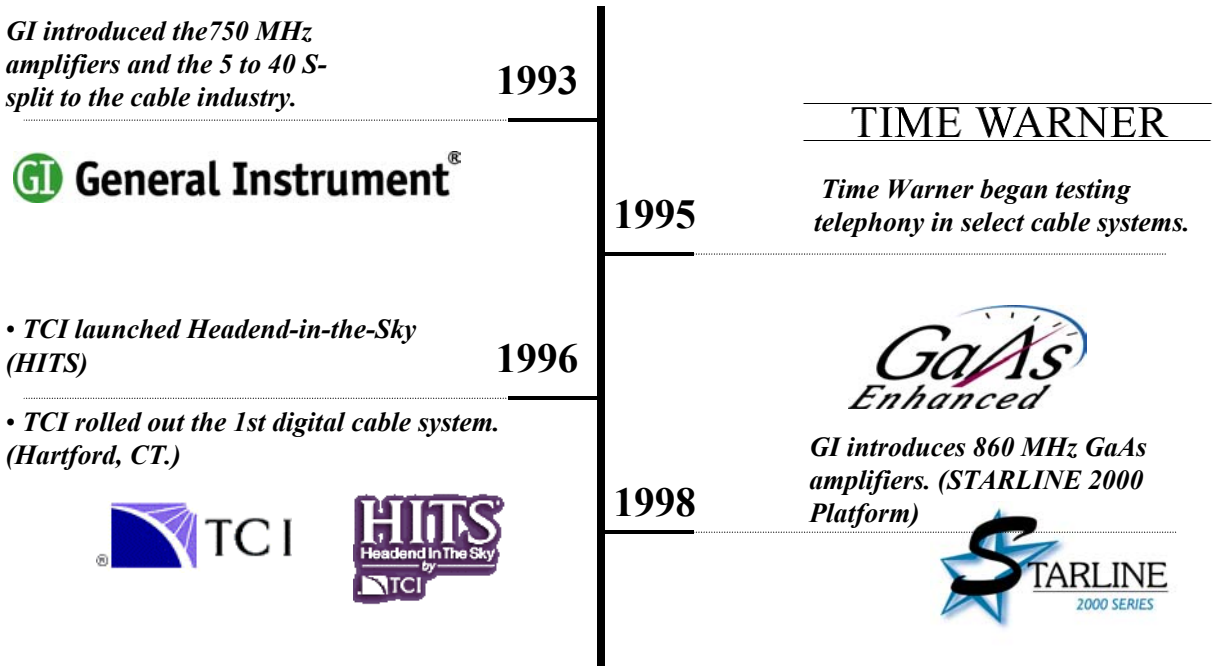



**Figure 1-8 CATV, 1993 to 1998**

## 2000 and Beyond

America's thirst for quality television has been the driving force behind the cable industry's growth. The willingness to invest in new technologies and programming has made cable television more than just an antenna service -- it is now an integral part of America's culture. The history of cable television is still evolving. The enactment in February 1996 of the sweeping telecommunications reform law; the first comprehensive rewrite of federal telecommunications law since 1934 -- will have a dramatic impact on the industry's development. As it opens up local telephone markets to competition for the first time and brings regulatory relief and flexibility to cable companies, the historic new law will continue to spur robust growth of the cable industry. Significant investments in new infrastructure and services are expected as cable companies fully enter the wireline and wireless telephone and data services markets.

Cable also promises to be a major player in online services, data delivery and high-speed access to the Internet. Due to cable's use of fiber optics and coaxial cable, cable systems, using high speed cable modems, can offer access at speed hundreds times faster than traditional telephone lines.

In addition, many cable companies offering high speed internet access have also developed local content to give users access to community information. Some cable-sponsored online services include MediaOne Express, Time Warner's Road Runner, Cablevision System's Optimum Online, and @Home, a joint venture of TCI, Cox Communications, Comcast and Kleiner, Perkins, Caufield and Byers.

Cable networks have also led the way in development of top quality Internet sites, including such offerings as ESPN Sports Zone, Discovery Online and CNN Interactive.

## Top 10 MSOs

| MSO | Estimated Subscribers, March 1998 |
|---|---|
| Tele-Communications Inc., (TCI) | 13,059,000 |
| Time Warner Cable | 12,600,000 |
| MediaOne Group | 4,933,000 |
| Comcast Corporation | 4,465,000 |
| Cablevision Systems Corporation | 3,406,000 |
| Cox Communications, Inc. | 3,264,000 |
| Adelphia Communications | 1,998,000 |
| Jones Intercable | 1,391,000 |
| InterMedia Partners | 1,333,000 |
| Century Communications Corp. | 1,321,000 |

## Top 10 Cable Networks

| Network Programming | Subscribers | Affiliate |
|---|---|---|
| Discovery Channel | 75,300,000 | 10,882 |
| TBS Superstation | 75,000,000 | 11,668 |
| C–SPAN (Cable Satellite Public Affairs Network) | 74,100,000 | 6,404 |
| FOX Family Channel | 73,000,000 | 10,880 |
| ESPN | 73,000,000 | 27,600 (Includes noncable service) |
| CNN (Cable News Network) | 73,000,000 | 11,528 cable |
| Lifetime Television (LIFE) | 72,500,000 | 11,000 (cable systems in the US) |
| TNN: The Nashville Network | 72,400,000 | N/A |
| A&E Television Network (A&E) | 72,000,000 | 12,000 (US and Canada) |
| The Weather Channel | 71,600,000 | 7,000 |

Section 2

# What is TV?

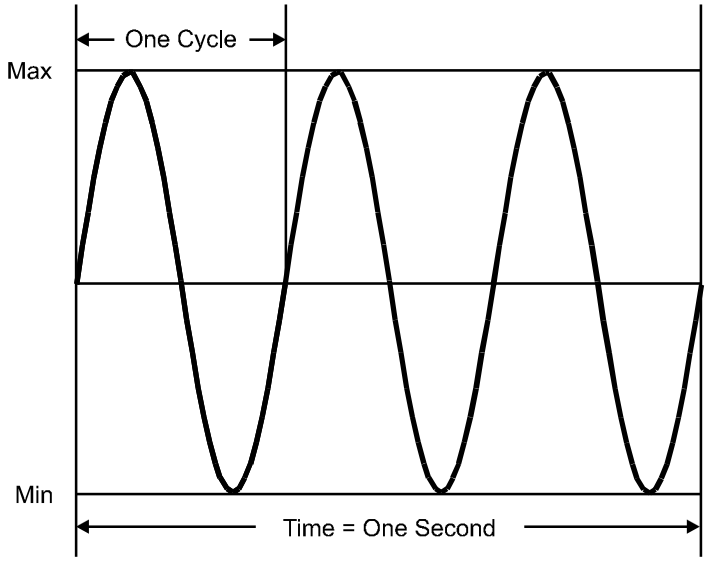
After completing this section of the course, you will:

- Understand the terminology in discussing television as it applies to cable television or broadband communication networks.
- Identify basic elements of signal transmission.
- Recognize a NTSC TV signal and identify the bandwidth of the audio and color sub-carrier.

## Radio Waves

Radio Waves, a part of the Electromagnetic spectrum, by definition are alternating waves starting at zero amplitude, increasing to a maximum amplitude, decreasing to zero amplitude, further decreasing to a minimum value amplitude and finally increasing back to zero amplitude. This complete "Cycle" of electrical values when referenced to one second determines the frequency of the radio wave. The term "Cycles Per Second" is commonly expressed as Hertz.

- **(kHz) Kilohertz** - One thousand cycles per second.
- **(MHz) Megahertz** - One million cycles per second.
- **(GHz) Gigahertz** - One billion cycles per second ($10^9$)
- **(RF) Radio Frequency -** The electromagnetic spectrum between 3 kHz and 300 GHz.




$$\text{wavelength} = \frac{\text{speed of light}}{\text{frequency}}$$

$$\text{wavelength in inches} = \frac{11{,}811}{\text{frequency in MHz}}$$

**Figure 2-1 A Three-Hertz Signal**

A CW or continuous wave is used as a carrier to broadcast signals. Two types of modulation are used in standard broadcasting: amplitude modulation (AM) and frequency modulation (FM).

## Amplitude Modulation

Amplitude modulation is achieved by superimposing a signal varying in amplitude onto a radio frequency carrier. The amplitude of the modulating signal determines the magnitude of carrier amplitude change. The frequency of the modulating signal determines the rate of change of carrier amplitude.

Analog TV transmission uses amplitude modulation for the video portion of the TV signal.

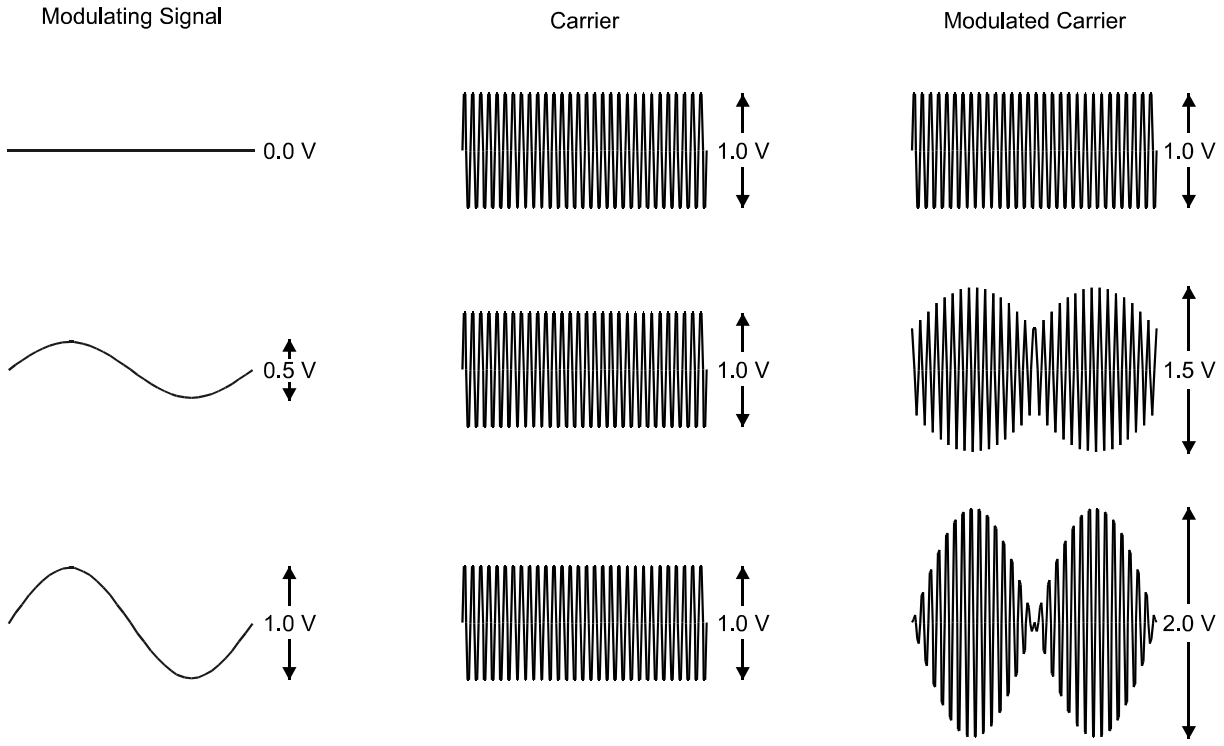



**Figure 2-2 Amplitude Modulation**

## Frequency Modulation

Frequency modulation is achieved by varying the frequency of the carrier in accordance with the modulating signal. The amplitude of the modulating signal determines the magnitude of carrier frequency change. The frequency of the modulating signal determines the rate of change of carrier frequency.

Analog TV transmission uses frequency modulation for the audio portion of the TV signal.

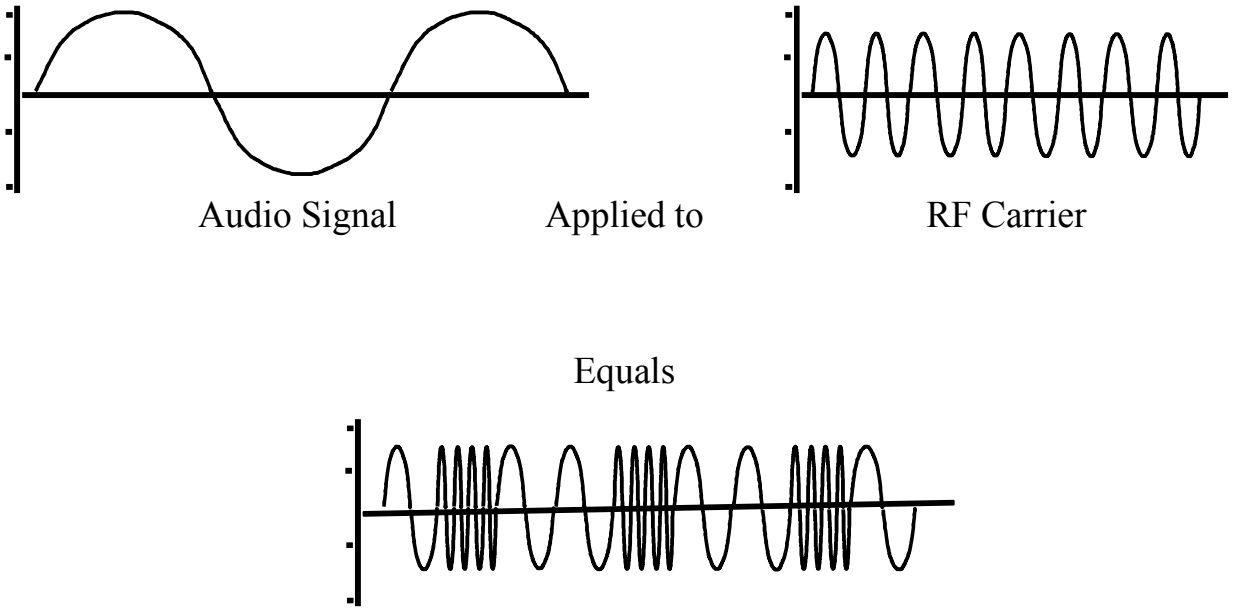



**Figure 2-3 Frequency Modulation**

The audio carrier for channel two is 59.75 MHz. When no audio is transmitted the carrier is constant at 59.75 MHz. When the loudest sound is transmitted, such as an explosion or gunshot, the greatest frequency deviation occurs. In broadcast television this frequency shift is limited to ±25 kilocycles. This is called 100% modulation (established by the FCC). Therefore, the audio carrier would move between 59.725 MHz (59.75 - 0.025) and 59.775 MHz (59.75 + 0.025) when 100% modulated.

The increase/decrease in frequency is a function of the loudness of the sound (amplitude). The rate of change of frequency is a function of the frequency of the audio modulating voltage.

## Scanning

Television broadcast is accomplished by transmitting fields of scanned information. Two fields of 262.5 lines are scanned by the TV camera and re-scanned by the television receiver.

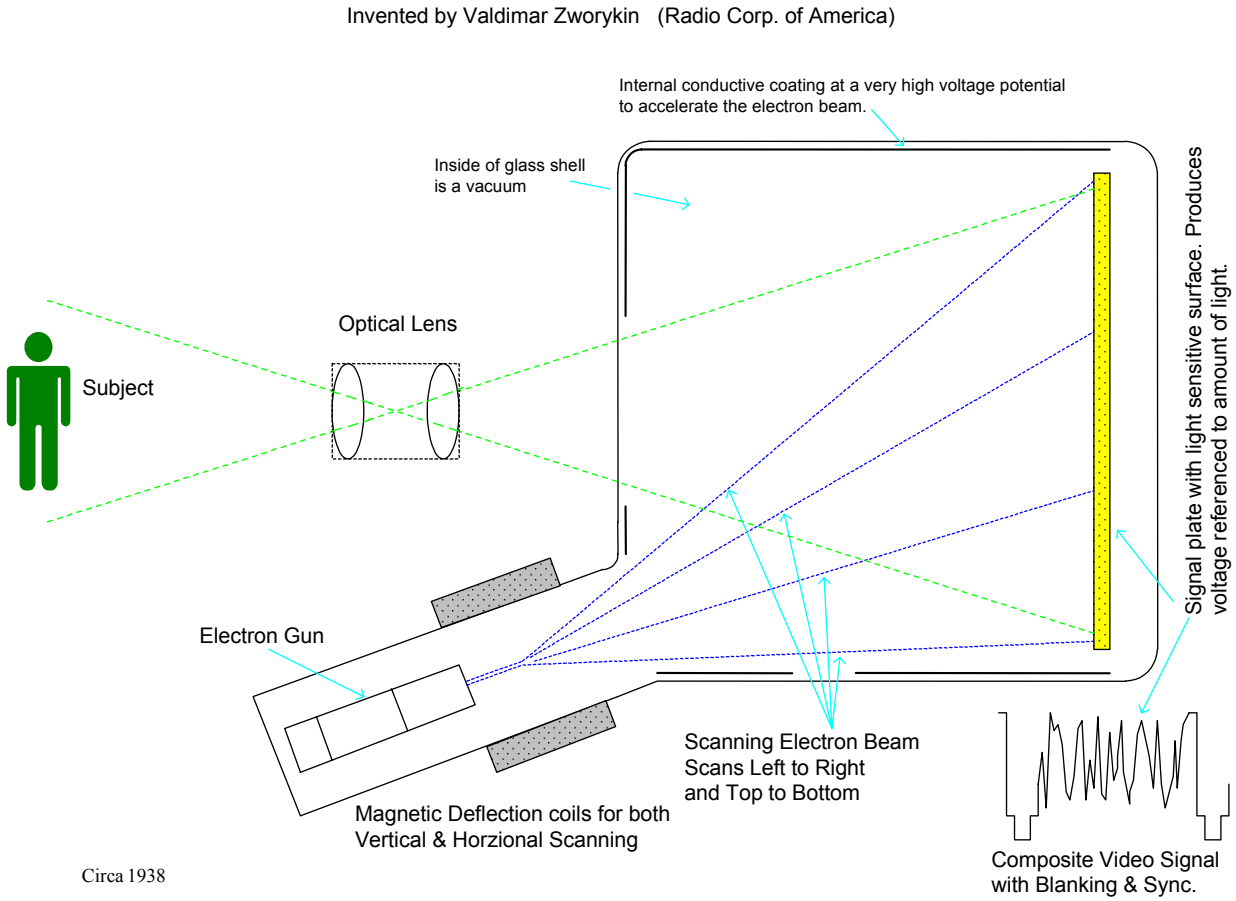

Invented by Valdimar Zworykin (Radio Corp. of America)
Internal conductive coating at a very high voltage potential to accelerate the electron beam.
Inside of glass shell is a vacuum
Optical Lens
Subject
Electron Gun
Signal plate with light sensitive surface. Produces voltage referenced to amount of light.
Scanning Electron Beam Scans Left to Right and Top to Bottom
Magnetic Deflection coils for both Vertical & Horzional Scanning
Composite Video Signal with Blanking & Sync.
Circa 1938

**Figure 2-4 The Original Iconoscope**

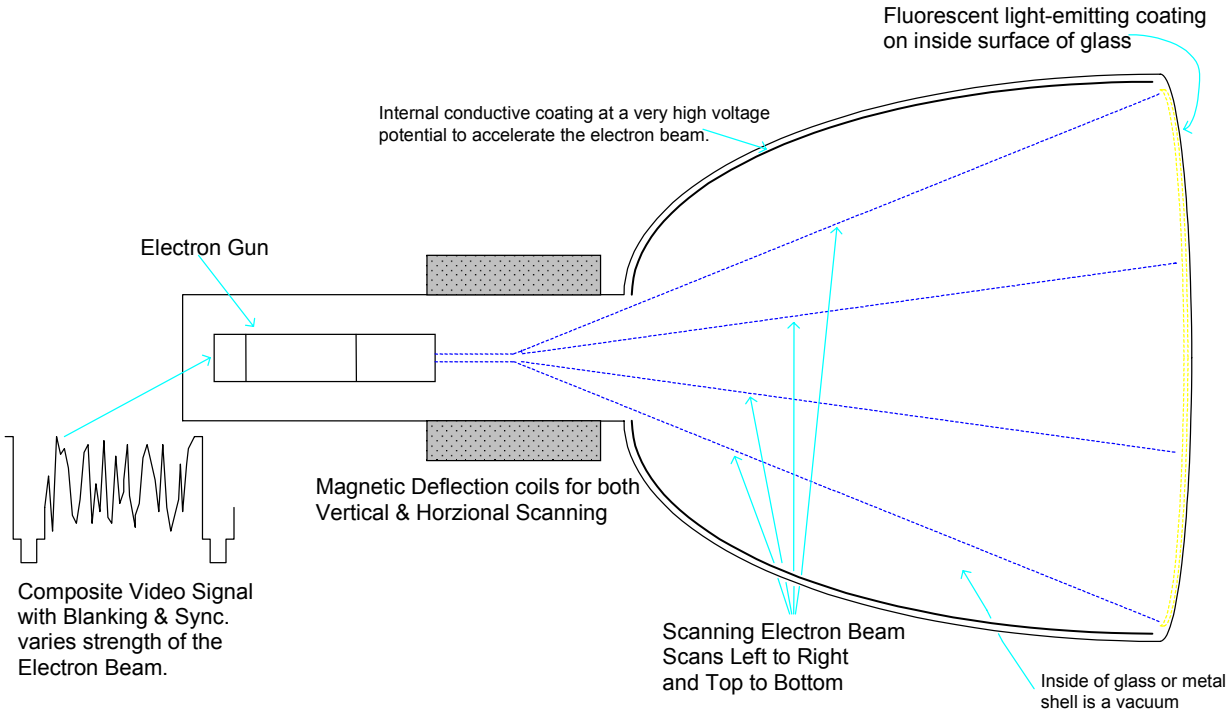

Fluorescent light-emitting coating
on inside surface of glass
Internal conductive coating at a very high voltage
potential to accelerate the electron beam.
Electron Gun
Magnetic Deflection coils for both
Vertical & Horzional Scanning
Composite Video Signal
with Blanking & Sync.
varies strength of the
Electron Beam.
Scanning Electron Beam
Scans Left to Right
and Top to Bottom
Inside of glass or metal
shell is a vacuum

**Figure 2-5 Cathode Ray Tube**

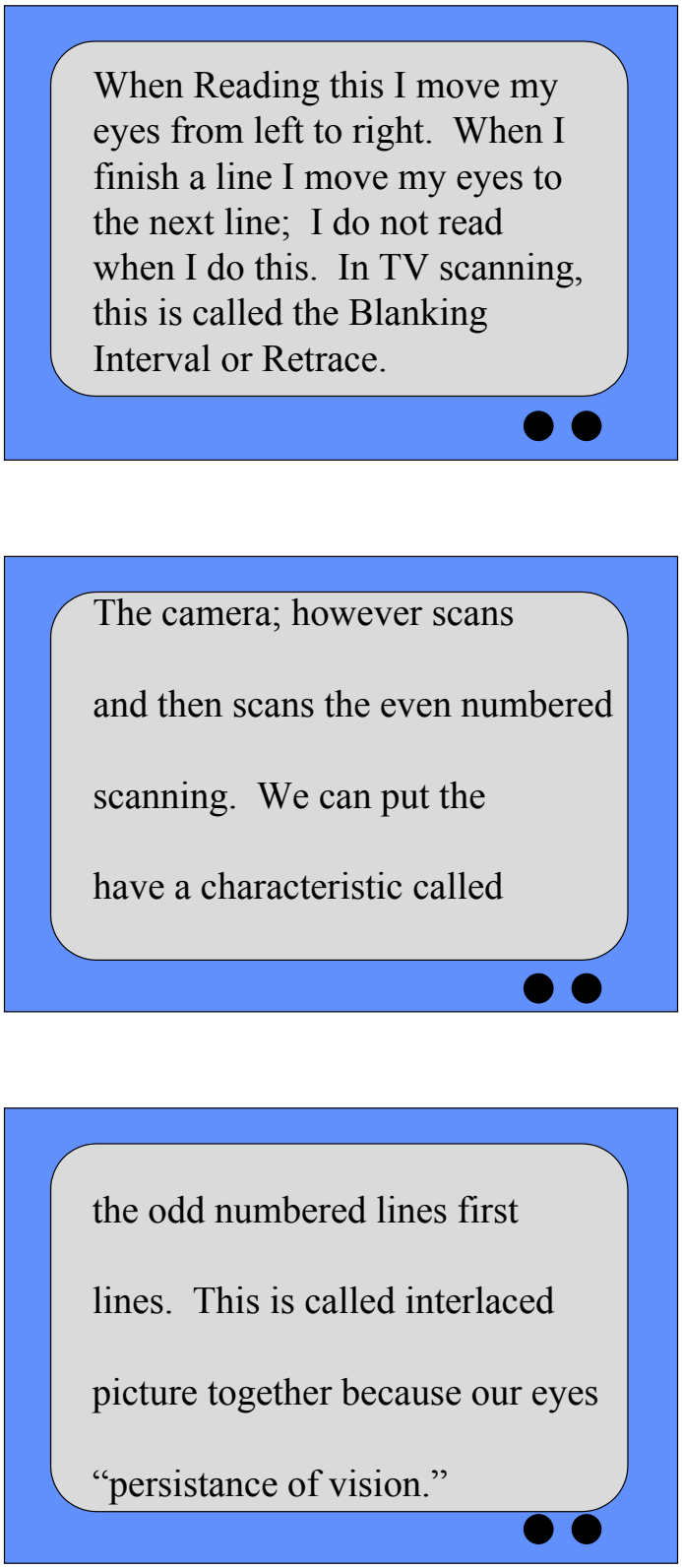

When Reading this I move my eyes from left to right. When I finish a line I move my eyes to the next line; I do not read when I do this. In TV scanning, this is called the Blanking Interval or Retrace.
The camera; however scans
and then scans the even numbered
scanning. We can put the
have a characteristic called
the odd numbered lines first
lines. This is called interlaced
picture together because our eyes
“persistance of vision.”

**Figure 2-6 Scanning**

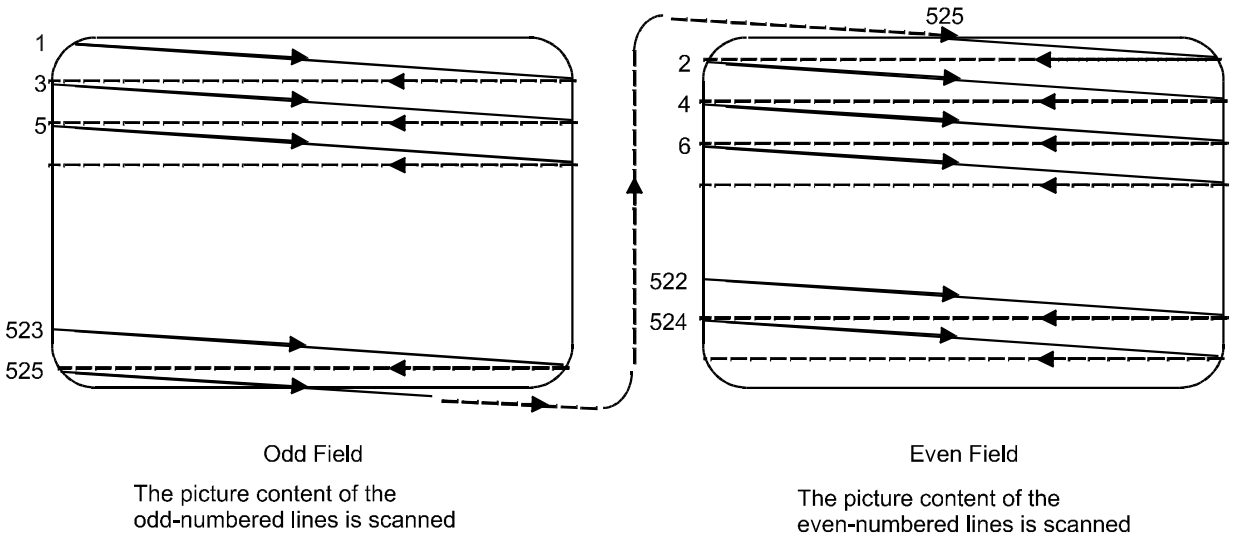



**Figure 2-7 Scanning the TV Picture**

The following table lists the standards for scanning an NTSC picture.

| | Color | Black and White |
|---|---|---|
| **Horizontal Trace Time** | 52.5 µsec | 53.3 µsec |
| **Horizontal Retrace Time** | 11.1 µsec | 10.2 µsec |
| **Total horizontal Scan time** | 63.6 µsec | 63.5 µsec |
| **Horizontal Scan Frequency** | 15,734 Hz | 15,750 Hz |
| **Vertical Trace Time** | 15,399 µsec | 15,396 µsec |
| **Vertical Retrace Time** | 1,294 µsec | 1,271 µsec |
| **Total Vertical Trace Time** | 16,683 µsec | 16,667 µsec |
| **Vertical Scan Frequency** | 59.94 Hz | 60 Hz |

Reproduction of a television scene on a CRT requires synchronization of the electron beams between the camera and the TV receiver. To accomplish an intelligent picture reconstruction; sync pulses are added within the blanking interval. Equalizing pulses keep the horizontal oscillator synchronized during the vertical blanking interval.

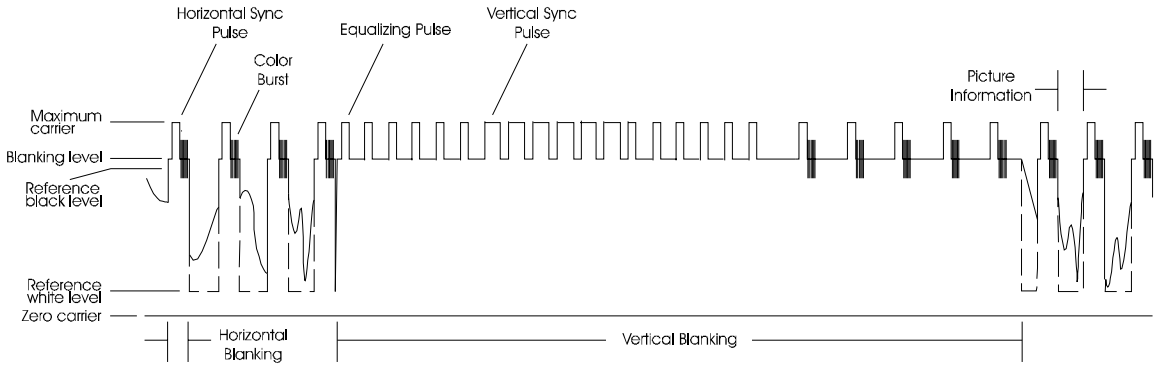



**Figure 2-8 Synchronizing Waveforms**

To broadcast the video and audio signals over-the-air they are superimposed on RF carriers. The video is amplitude modulated and the audio is frequency modulated.

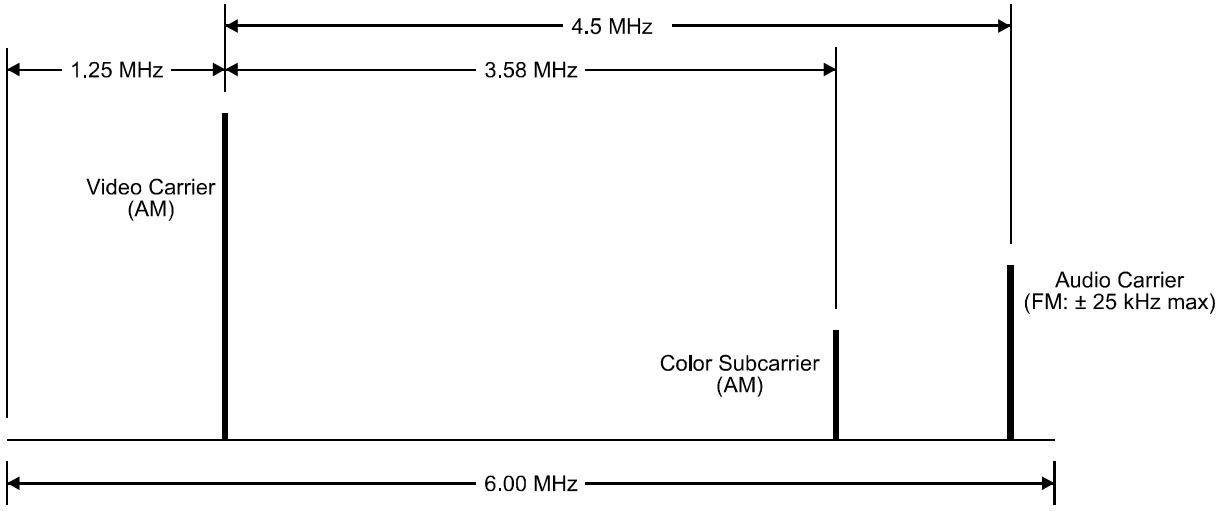



**Figure 2-9 Components of TV Signal**

Section 3

# Bandwidth

After completing this section of the course, you will be able to:

- ❒ Identify analog & digital services spectrum allocations.
- ❒ Understand the current/future services to be transmitted & their bandwidth requirements

## Current Model

Spectrum available is 696 MHz

1 NTSC analog channel = 6 MHz

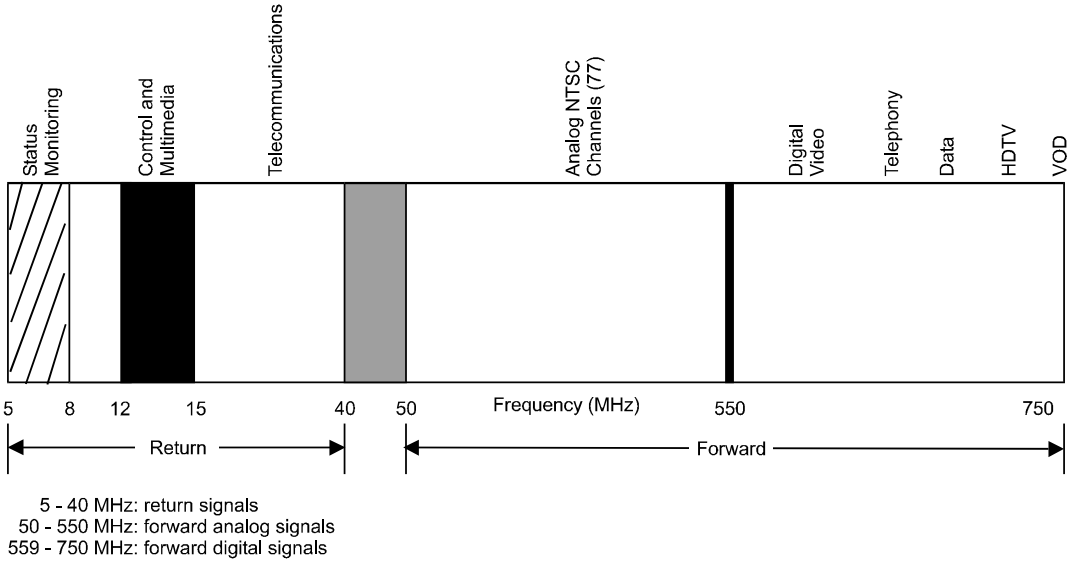
696 MHz / 6 MHz = 116 available analog channels

Using digital compression:

- Four 6.0 Mbps channels (video) per 6 MHz
- Eight 3.0Mbps channels (VOD) per 6 MHz
- Sixteen 1.5 Mbps channels (games, data) per 6 MHz

Combining analog and digital:

- 77 analog channels in the 54-550 MHz passband
- 68 digital channels (6 Mbps each) in the 550-650 MHz passband
- 128+ IMTV(interactive multimedia) channels in the 650-750 MHz passband
- 273 total channels



Section 4

# Headend

When this section is completed you will be able to:

- Define the major components of the Headend and explain their function.
- Identify the necessary equipment that is crucial to Network Operations.

## Cable System (Broadband Communications Network)

A cable system or Broadband Communications Network consists of the following major components:

- Headend
- Distribution System
- Customer Premises Equipment

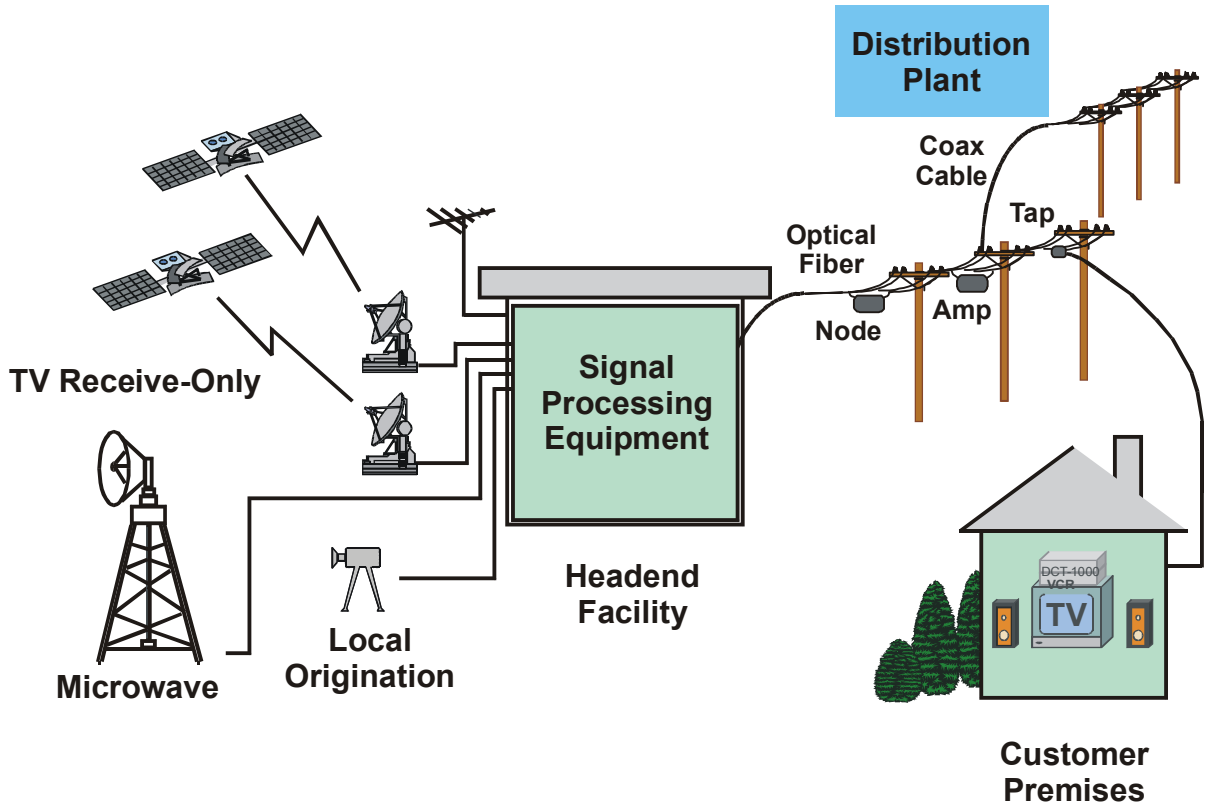



**Figure 4-1 Cable System Diagram**

## Signal Collection

The real estate used to collect video, data, RF, and digital signals is called the Headend. Examples of signals collected include satellite delivered analog and digital, broadcast RF (VHF and UHF), pre-recorded videotapes, microwave AM and FM, baseband video, data and telephony. The collected signals are then multiplexed and/or combined for input into the distribution system via RF distribution amplifiers or light amplification by stimulated emission of radiation (Laser). The Headend must also process all return signals from the distribution system.

- (VHF) Very High Frequency - Corresponding to electromagnetic signals in the range from 30 to 300 MHz; channels 2 to 13.
- (UHF) Ultra High Frequency - Corresponding to electromagnetic signals in the range from 300 to 3,000 MHz; channels 14 to 69 are commonly referred to as UHF channels on the television dial.

# Headend Components

## Signal Collectors

- VHF and UHF Antenna
- Satellite Dish (TVRO)
- Microwave Antenna
- Videotape Players
- Telephone Line (DS-0)
- Character Generators

## Distribution System Access/Multiplexing

- Network Combiner
- Post Amplifiers
- Broadband Optical Transmitter
- Amplifiers
- Optical Splitters
- Return Path Amplifiers, Optical Transmitters, and Optical Receivers

## Signal Processors/Network Control

- Modulators
- Processors
- De-modulators
- Satellite Receivers
- Security Scramblers
- Audio Modulators
- Stereo Encoders
- Data Encoders
- Weatherstar
- Addressable Controller

- Operational Support Systems
- Status Monitoring

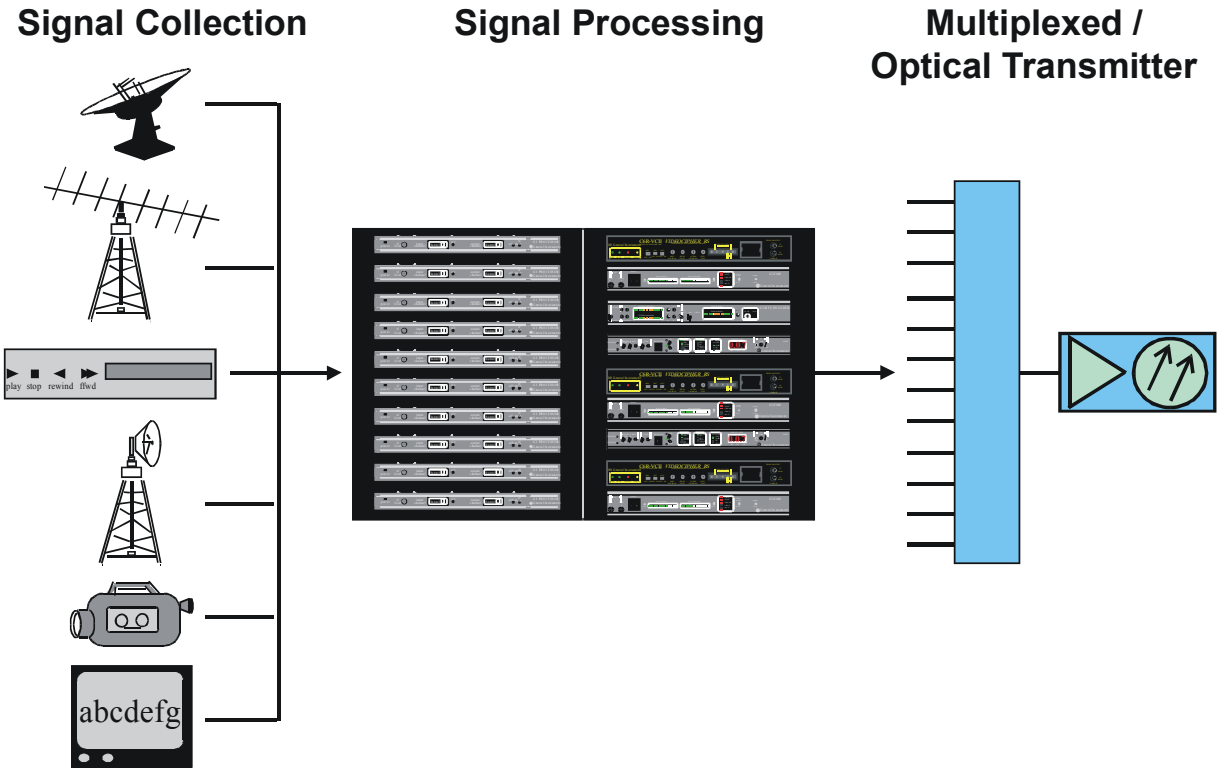



**Figure 4-2 Headend Components Diagram**

## Satellite Transmission

From a geostationary orbit, 22,275 miles above the Earth, a communications satellite receives signals in the 5.9 to 6.4 GHz band from an uplink site. Using directional antennas the signals are relayed to Earth in the 3.7 to 4.2 GHz band. A transponder on board the satellite handles the frequency conversion for each 24 or 36 MHz channel. The transponder functions like an analog repeater.

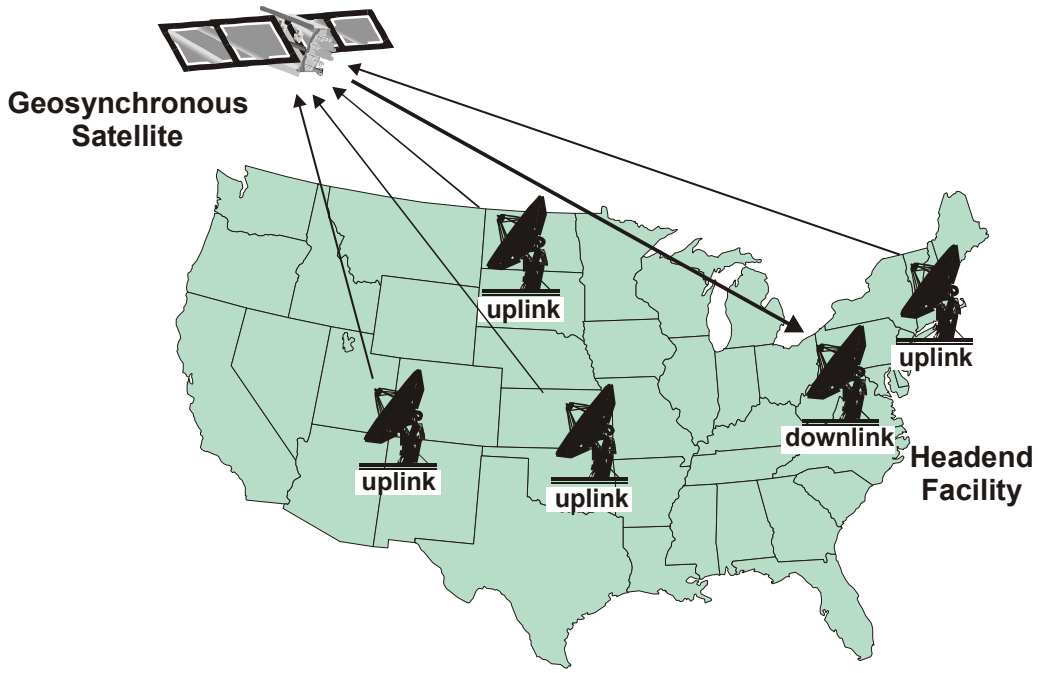



**Figure 4-3 Satellite Transmission**

## Satellite Signals Converted to RF

The 3.7 to 4.2 GHz band signal is collected by the parabolic antenna and converted to a 950 to 1450 MHz signal by a low noise block converter*. The power divider provides inputs to multiple receivers.

***Note:** *The 3.7 to 4.2 GHz band is somewhat affected by heavy rainfall and of course the antenna is prone to snow fade when snow accumulates in the dish.*

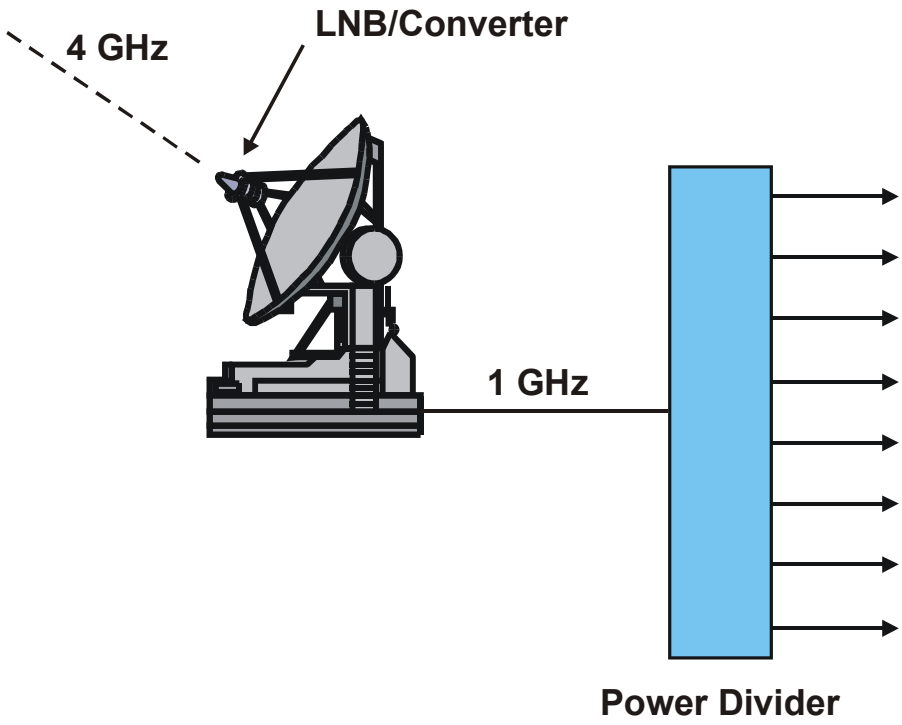



**Figure 4-4 Satellite Signal Converted to RF Diagram, Converter**

## Analog Receiver Descrambler

The 950 MHz to 1,450 MHz band signal is descrambled (decoded) and demodulated to video and audio components using a satellite receiver/decoder.

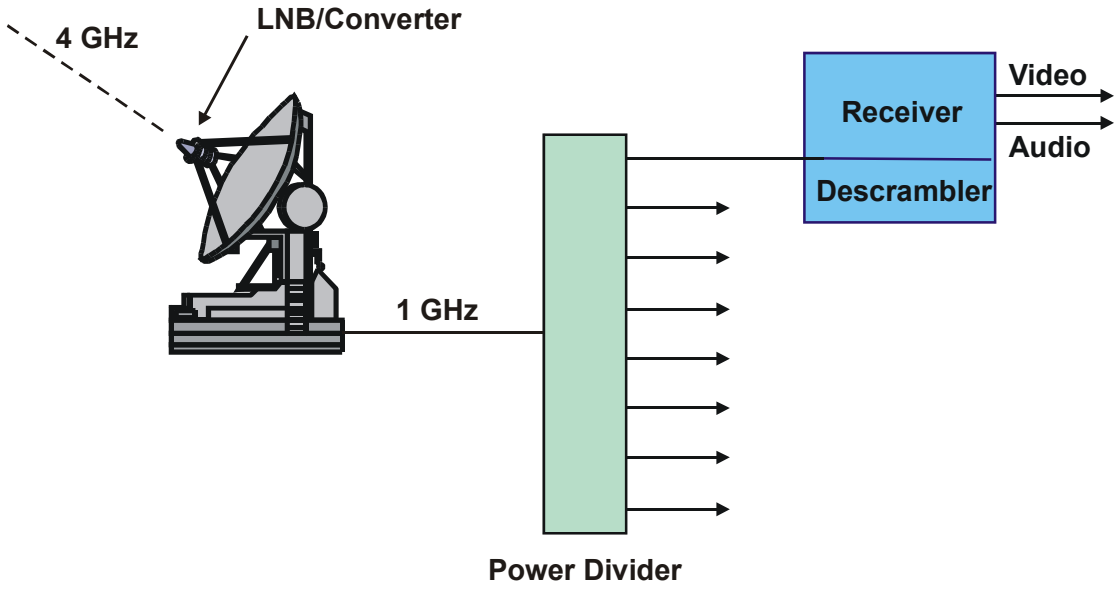



**Figure 4-5 Satellite Signal Converted to RF, Analog Receiver Descrambler**

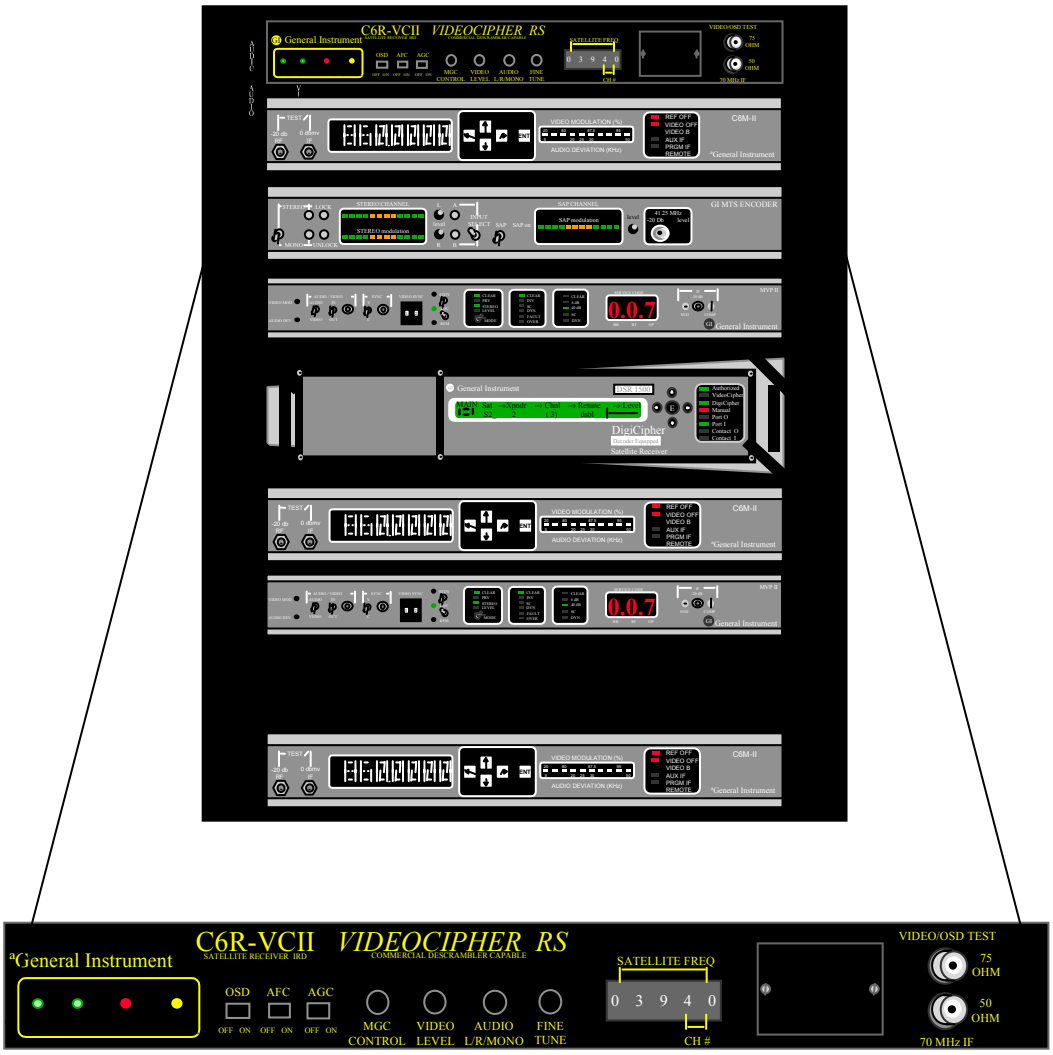



**Figure 4-6 Analog Receiver Descrambler**

## RF Modulator

The modulator assigns the video and audio to selected carriers (TV channels). The IF (Intermediate Frequency) of the video is 45.75 MHz and 41.25 MHz for the audio and is available for processing. The output signal relationship of Video-Audio is reversed (NTSC format).

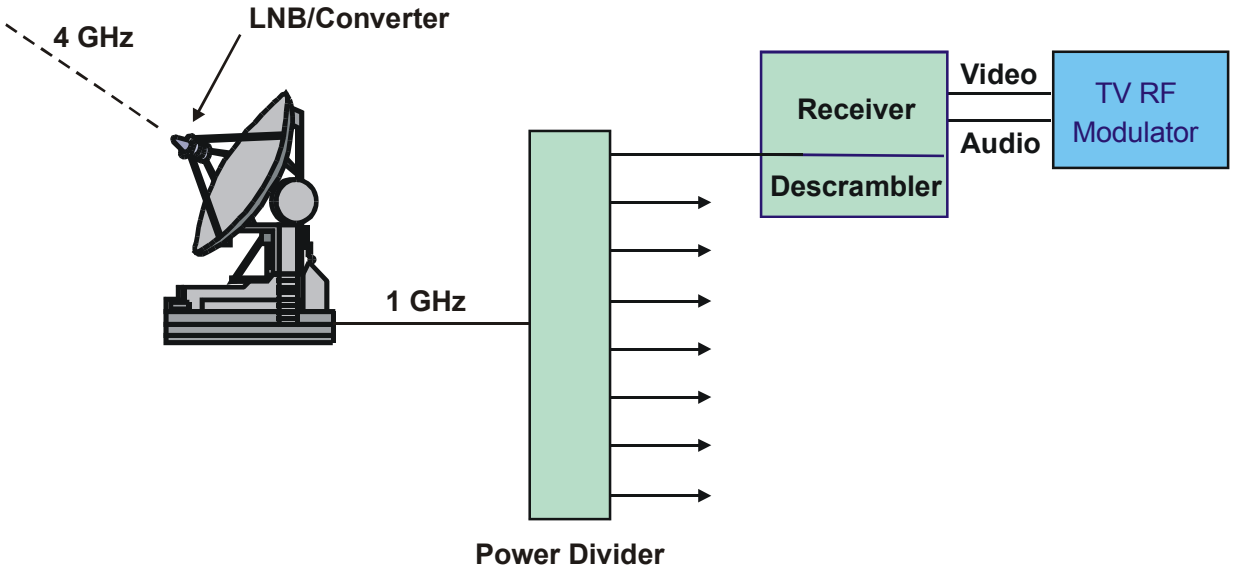



**Figure 4-7 Satellite Signal Converted to RF, RF Modulator**

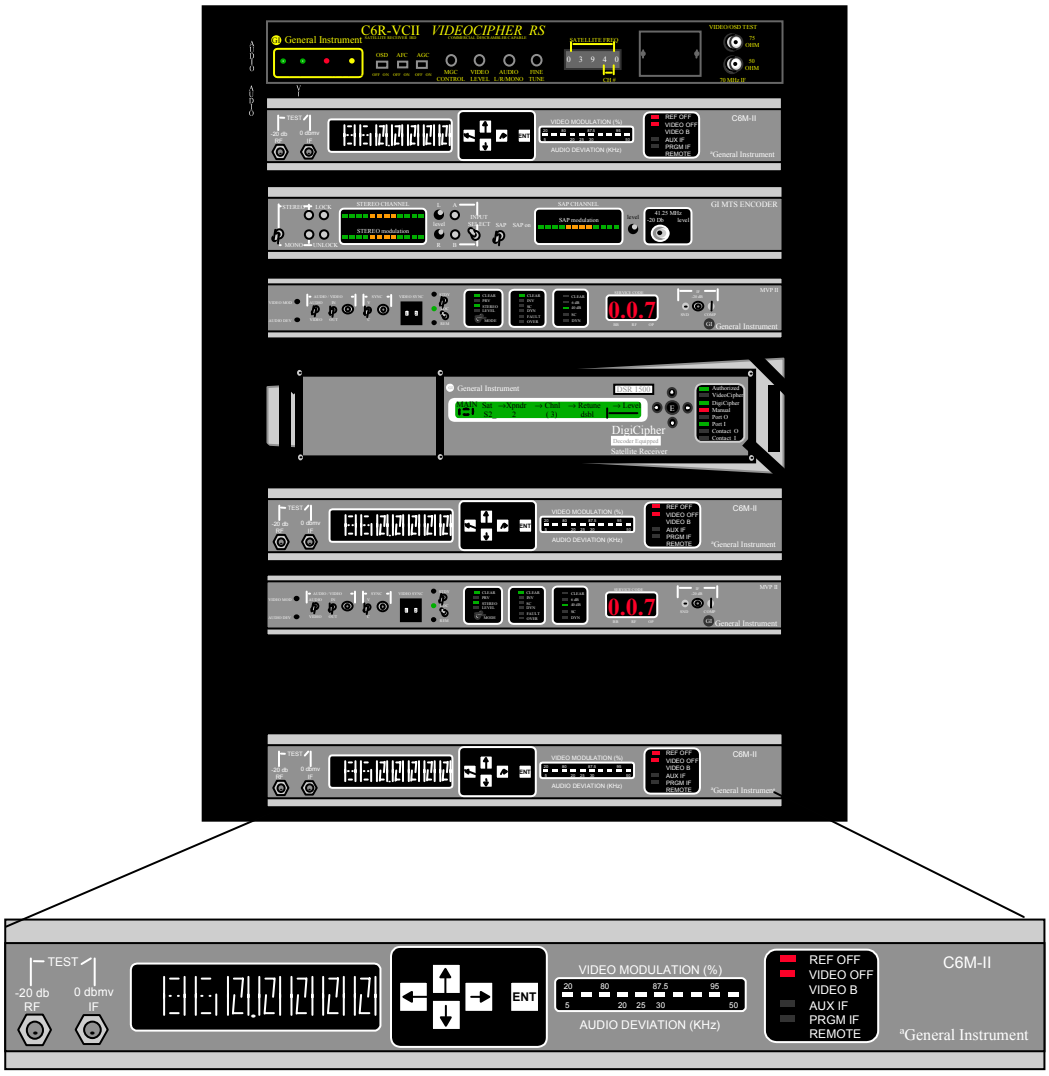



**Figure 4-8 RF Modulator**

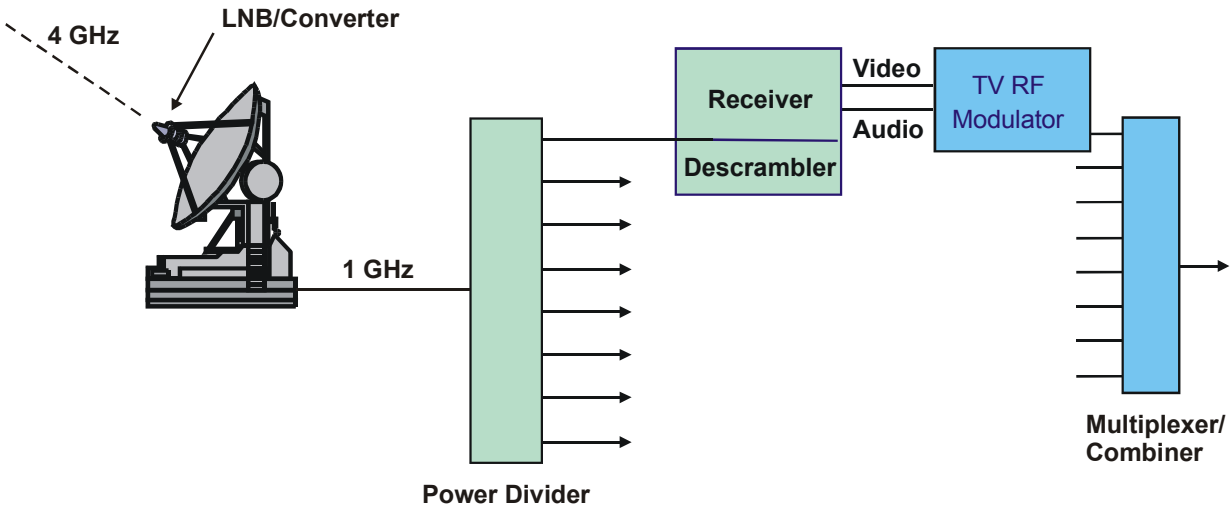



**Figure 4-9 Entire Satellite Signal Converted to RF**

## Review

1 What are the intermediate frequencies for processing in a RF modulator:

   **a** Audio _____

   **b** Video _____

2 What is the radio frequency range available to programmers to uplink to a geostationary satellite transponder?

_____

3 What is the bandwidth of each channel uplinked?

_____

4 What is the bandwidth of a NTSC TV channel?

_____

# Broadcast TV Transmission

## Log-Periodic Antenna

A Log-Periodic Antenna is used to receive VHF television channels. It is located at the headend site.

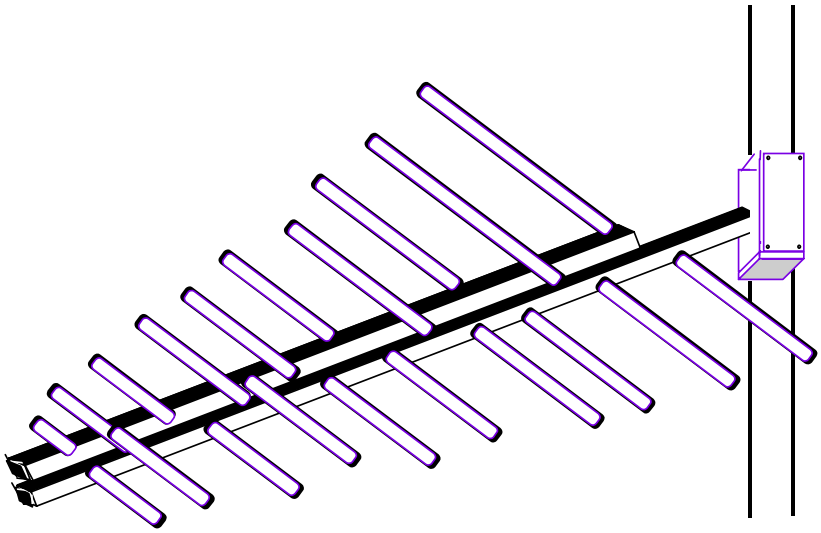


**Figure 4-10 Log-Periodic Antenna**

## Yagi Antenna

Yagi antennas are utilized for the reception of off-air VHF signals generated by television broadcast companies; channels 2 to 6 (VHF low-band) or 7 to 13 (VHF high-band).

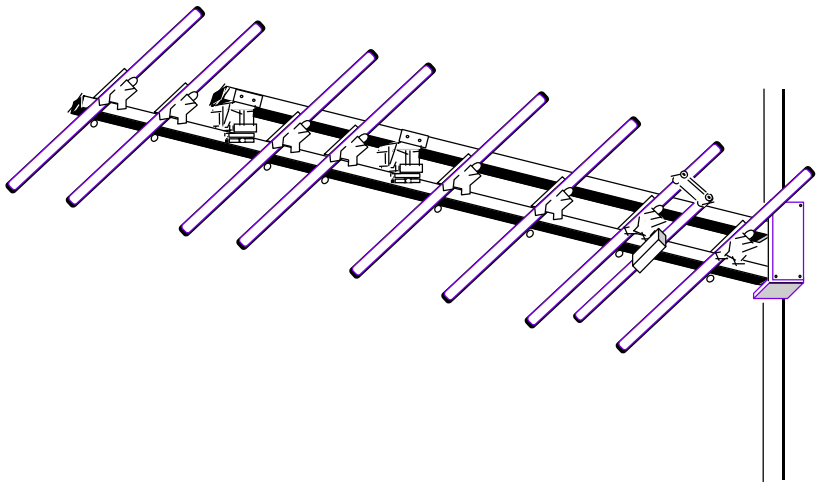


**Figure 4-11 Yagi Antenna**

## Heterodyne Processor

The Heterodyne processor downconverts the incoming signal to an intermediate frequency (IF) for filtering, processing and level control. The signal is then reconverted to the original RF carrier or to a new desired carrier frequency.

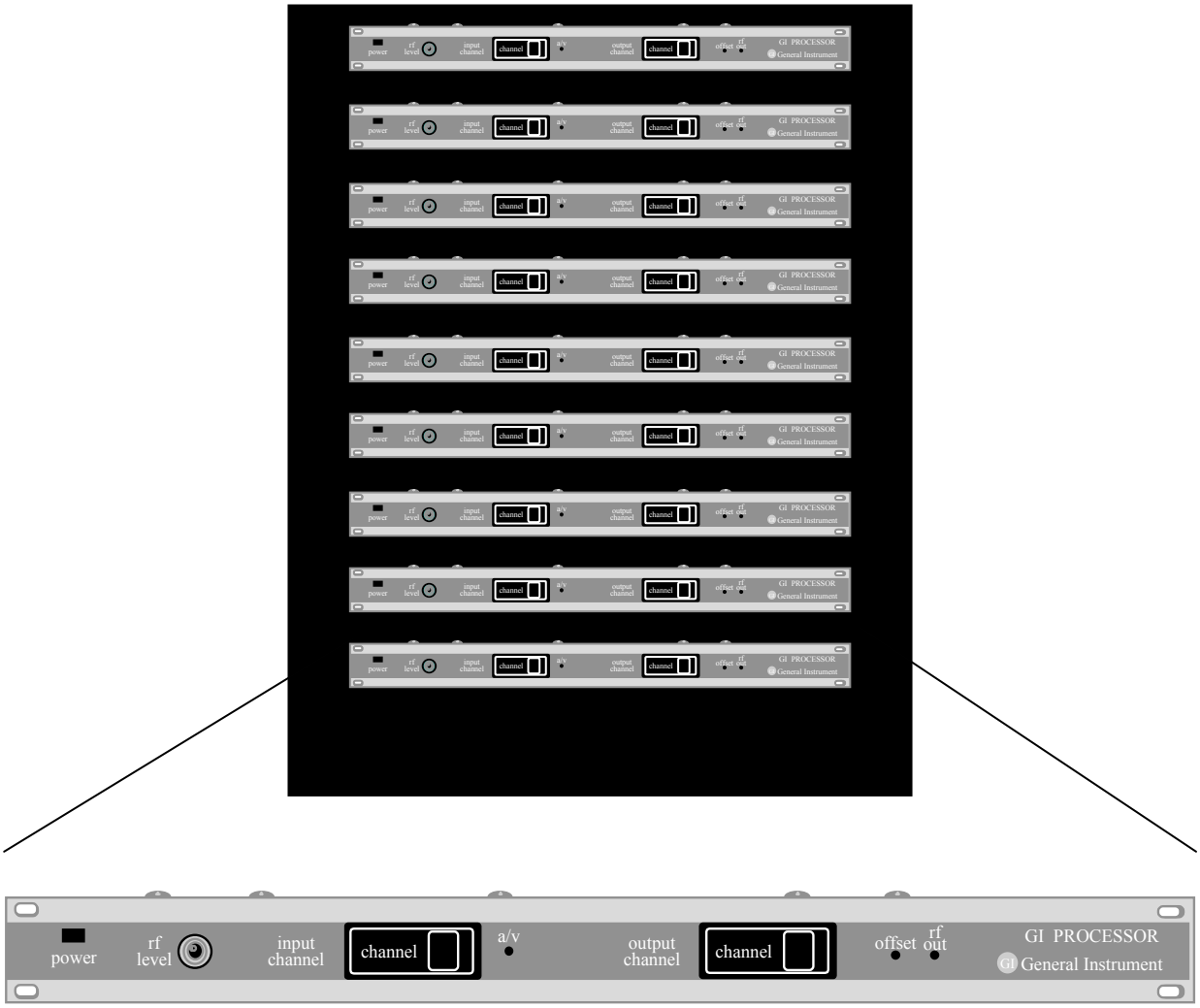



**Figure 4-12 Heterodyne Processor**

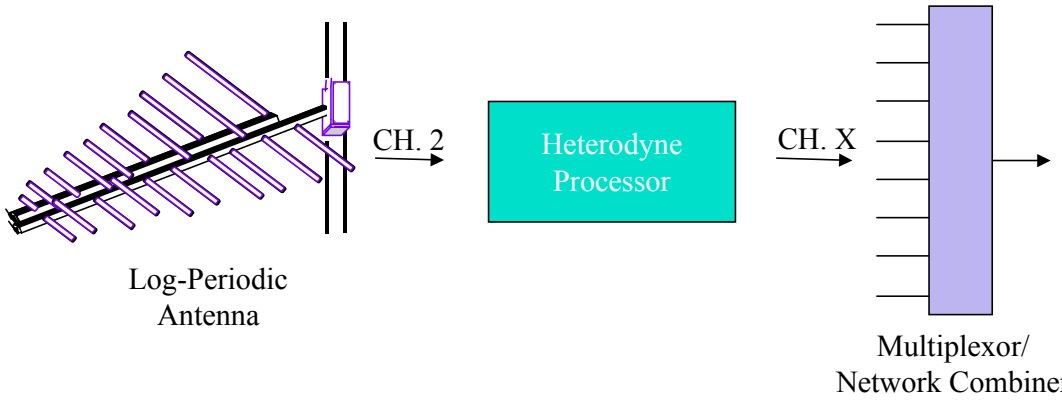



**Figure 4-13 Broadcast TV Signals Converted to Network RF, Heterodyne Processor**

## Off-Air Television Channels

Television channels that can be received on a VHF antenna are numbered 2 to 13. If two major markets (i.e.; Kansas City and St. Louis) both have been allocated the same channel (such as channel 2), they can be assigned one of three ways; on-frequency, a plus (+) offset or a minus (-) offset from the standard frequency. This offset is ±10 Kilohertz.

| Channel Number | Picture Carrier Frequency MHz | Color Carrier Frequency MHz | Sound Carrier Frequency MHz | Wavelength (inch) |
|---|---|---|---|---|
| | | VHF Television Frequencies | | |
| 2 | 55.25 | 58.83 | 59.75 | 213.8 |
| 3 | 61.25 | 64.83 | 65.75 | 192.8 |
| 4 | 67.25 | 70.83 | 71.75 | 175.6 |
| 5 | 77.25 | 80.83 | 81.75 | 152.9 |
| 6 | 83.25 | 86.83 | 87.75 | 141.9 |
| 7 | 175.25 | 178.83 | 179.75 | 67.4 |
| 8 | 181.25 | 184.83 | 185.75 | 65.2 |
| 9 | 187.25 | 190.83 | 191.75 | 63.1 |
| 10 | 193.25 | 196.83 | 191.75 | 61.1 |
| 11 | 199.25 | 202.83 | 203.75 | 59.3 |
| 12 | 205.25 | 208.83 | 209.75 | 57.5 |
| 13 | 211.25 | 214.83 | 215.75 | 55.9 |
| | | UHF Television Frequencies | | |
| 14 | 471.25 | 474.83 | 475.75 | 25.1 |
| 15 | 477.25 | 480.83 | 481.75 | 24.7 |
| 16 | 483.25 | 486.83 | 487.75 | 24.4 |
| 17 | 489.25 | 492.83 | 493.75 | 24.1 |
| 18 | 495.25 | 498.83 | 499.75 | 23.8 |
| 19 | 501.25 | 504.83 | 505.75 | 23.6 |
| 20 | 507.25 | 510.83 | 511.75 | 23.3 |
| 21 | 513.25 | 516.83 | 517.25 | 23.0 |
| 22 | 519.25 | 522.83 | 523.75 | 22.7 |
| 23 | 525.25 | 528.83 | 529.75 | 22.5 |
| 24 | 531.25 | 534.83 | 535.75 | 22.2 |

| Channel Number | Picture Carrier Frequency MHz | Color Carrier Frequency MHz | Sound Carrier Frequency MHz | Wavelength (inch) |
|---|---|---|---|---|
| 25 | 537.25 | 540.83 | 541.75 | 22.0 |
| 26 | 543.25 | 546.83 | 547.75 | 21.7 |
| 27 | 549.25 | 552.83 | 553.75 | 21.5 |
| 28 | 555.25 | 558.83 | 559.75 | 21.3 |
| 29 | 561.25 | 564.83 | 564.75 | 21.0 |
| 30 | 567.25 | 570.83 | 571.75 | 20.8 |
| 31 | 573.25 | 576.83 | 577.75 | 20.6 |
| 32 | 579.25 | 582.83 | 583.75 | 20.4 |
| 33 | 585.25 | 588.83 | 589.75 | 20.2 |
| 34 | 591.25 | 594.83 | 595.75 | 20.0 |
| 35 | 597.25 | 600.83 | 601.75 | 19.8 |
| 36 | 603.25 | 606.83 | 607.75 | 19.6 |

Television channels that can be received on an UHF antenna are numbered 14 through 69.

| Channel Number | Picture Carrier Frequency MHz | Color Carrier Frequency MHz | Sound Carrier Frequency MHz | Wavelength (inch) |
|---|---|---|---|---|
| 37 | | Radio Astronomy | | |
| 38 | 615.25 | 618.83 | 619.75 | 19.2 |
| 39 | 621.25 | 624.83 | 625.75 | 19.0 |
| 40 | 627.25 | 630.83 | 631.75 | 18.8 |
| 41 | 633.25 | 636.83 | 637.75 | 18.7 |
| 42 | 639.25 | 642.83 | 643.75 | 18.5 |
| 43 | 645.25 | 648.83 | 649.75 | 18.3 |
| 44 | 651.25 | 654.83 | 655.75 | 18.1 |
| 45 | 657.25 | 660.83 | 661.75 | 18.0 |
| 46 | 663.25 | 666.83 | 667.75 | 17.8 |
| 47 | 669.25 | 672.83 | 673.75 | 17.6 |
| 48 | 675.25 | 678.83 | 679.75 | 17.5 |
| 49 | 681.25 | 684.83 | 685.75 | 17.3 |
| 50 | 687.25 | 690.83 | 691.75 | 17.2 |

| Channel Number | Picture Carrier Frequency MHz | Color Carrier Frequency MHz | Sound Carrier Frequency MHz | Wavelength (inch) |
|---|---|---|---|---|
| 51 | 693.25 | 696.83 | 697.75 | 17.0 |
| 52 | 699.25 | 702.83 | 703.75 | 16.9 |
| 53 | 705.25 | 708.83 | 709.75 | 16.7 |
| 54 | 711.25 | 714.83 | 715.75 | 16.6 |
| 55 | 717.25 | 720.83 | 721.75 | 16.5 |
| 56 | 723.25 | 726.83 | 727.75 | 16.3 |
| 57 | 729.25 | 732.83 | 733.75 | 16.2 |
| 58 | 735.25 | 738.83 | 739.75 | 16.1 |
| 59 | 741.25 | 744.83 | 745.75 | 15.9 |
| 60 | 747.25 | 750.83 | 751.75 | 15.8 |
| 61 | 753.25 | 756.83 | 757.75 | 15.7 |
| 62 | 759.25 | 762.83 | 763.75 | 15.6 |
| 63 | 765.25 | 768.83 | 769.75 | 15.4 |
| 64 | 771.25 | 774.83 | 775.75 | 15.3 |
| 65 | 777.25 | 780.83 | 781.75 | 15.2 |
| 66 | 783.25 | 786.83 | 787.75 | 15.1 |
| 67 | 789.25 | 792.83 | 793.75 | 15.0 |
| 68 | 795.25 | 798.83 | 799.75 | 14.9 |
| 69 | 801.25 | 804.83 | 805.75 | 14.7 |

## Review

1 For a TV channel with a visual carrier frequency of 211.25 MHz:

a What is the sound carrier frequency? _____

b What is the color carrier frequency? _____

c What is the VHF TV channel number? _____

2 For TV channel four:

a What is the picture carrier frequency? _____

b What is the audio carrier frequency? _____

c What is the color carrier frequency? _____

## Headend Signal Processing

Equipment located in the Headend used to process the collected signals may include:

- Satellite Analog Receivers
- Satellite Digital Receivers
- Satellite Descramblers
- RF Modulators (Baseband video to RF)
- Processors (VHF/UHF to RF conversions)
- Microwave Receivers
- Emergency Broadcast Audio Override Controller
- Stereo Encoders
- Music Choice
- Demodulators
- Addressable Controller
- Channel Scramblers (Addressable Converters)
- Data Encoders
- Weatherstar
- Operational Support Systems

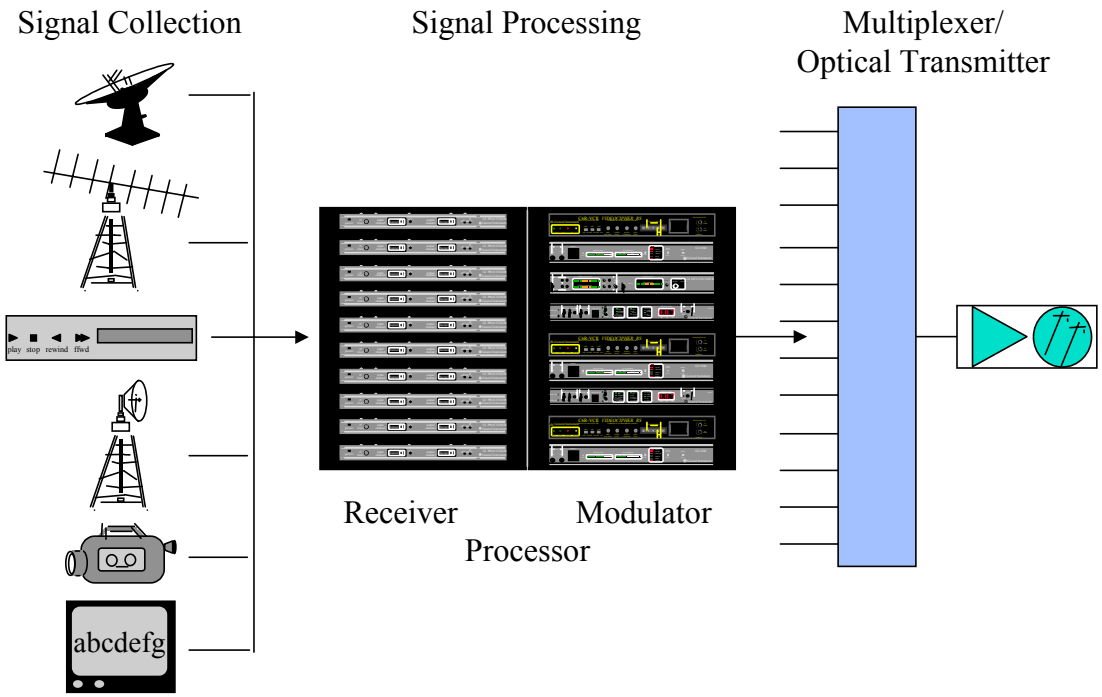



**Figure 4-14 Headend Components Diagram**

The individual channels from the TV (RF) modulators and heterodyne processors are combined using the network combiner. The combined signals are amplified by a low distortion post amplifier to provide the proper input signal levels to the optical transmitters.

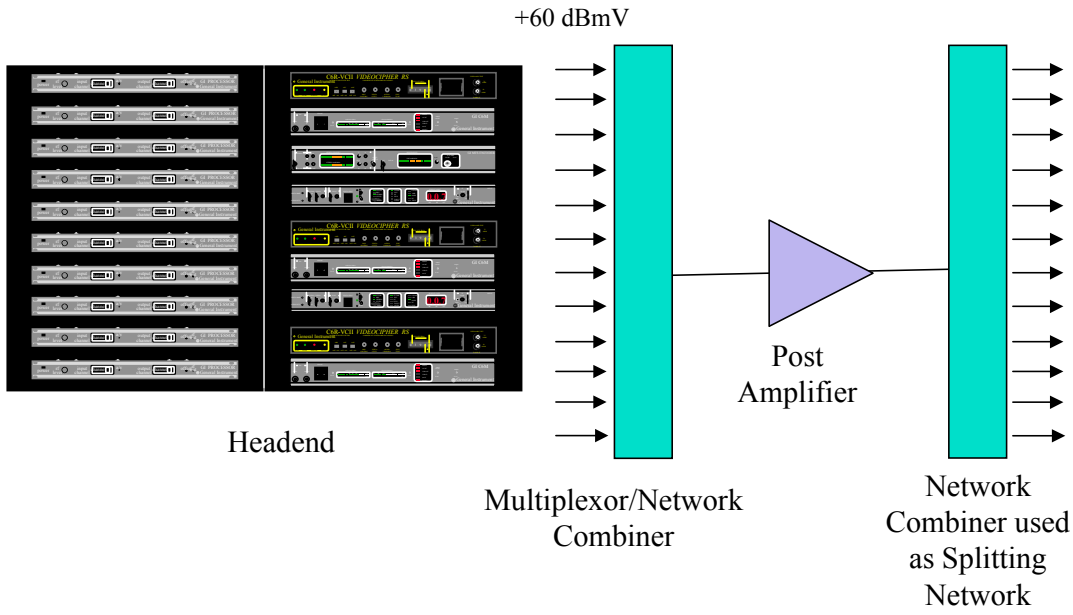



**Figure 4-15 Headend Output Diagram**

An adequate signal level of +15 dBmV is provided to the input of each DFB laser module.

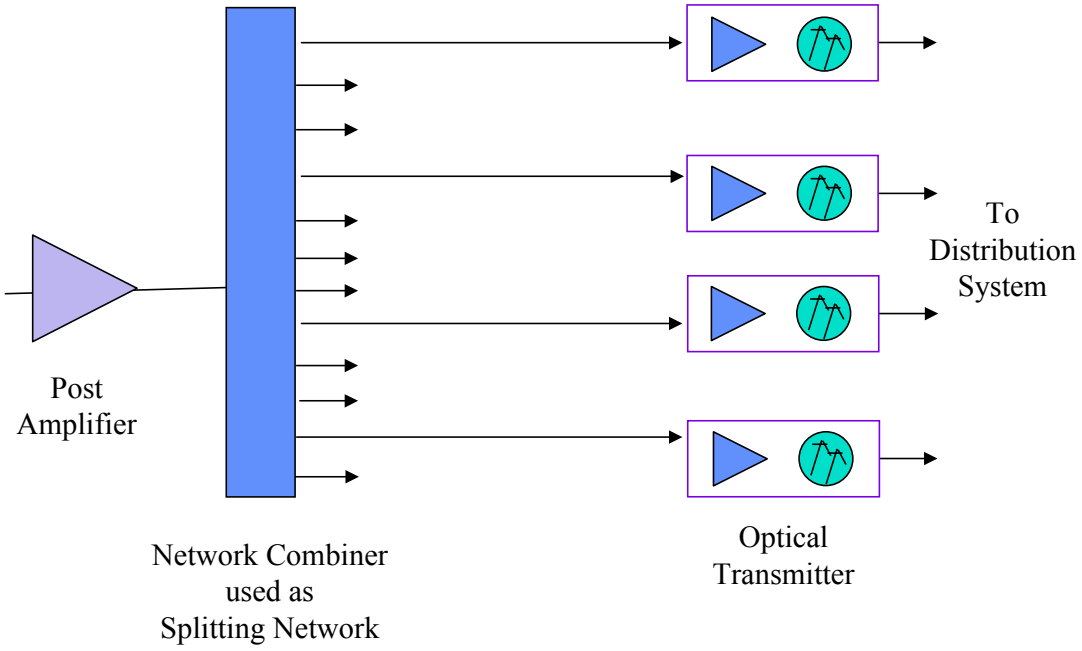



**Figure 4-16 Distribution System Access Diagram**

# Broadband Fiber-Optic Transmission

A typical application for a broadband communications network includes:

- A DFB (Distributed Feedback) Laser
- 1310 nm operational wavelength
- Single mode fiber with < .4 dB loss/kilometer
- Optical Splitters
- Photodetector Receiver
- Fabry-Perot Return Laser
- Optical Return Receiver

30

**Figure 4-17 Laser Transmitter**

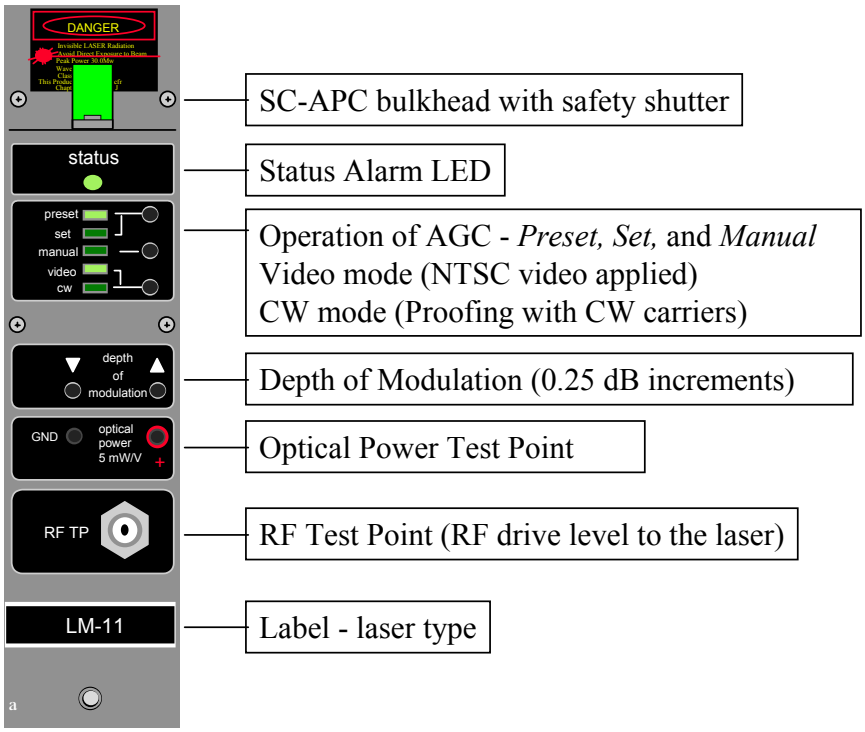



**Figure 4-18 Laser Module**

## Review

1 What are the three major components that make up a broadband communications network?

a _____

b _____

c _____

2 Name two types of signal collectors.

a _____

b _____

3 Name two types of signal processors or network control devices.

a _____

b _____

4 Name two types of distribution system access or multiplexing devices.

a _____

b _____

5 What do the terms VHF and UHF stand for? Name their frequency ranges.

_____

_____

6 In a geostationary orbit, a communications satellite receives signals in what bandwidth range?

_____

7 What device descrambles/decodes satellite signals?

_____

Section 5

# Distribution

When this section is completed you will be able to:

- Define the major components of a distribution system and explain their function.
- Identify the necessary equipment that is crucial to network operations.
- Understand the terms used to describe broadband communication.

## Distribution System Components

- Fiber Node
  - Fiber-Optic Cable
  - Photo Detector Receiver
  - Node Launch Amplifier
  - Return Transmitter
  - Block Converters
  - Maintenance Transponder
- Power Supplies
- Signal Transportation
  - Coaxial Cable
  - Splitters
  - Directional Couplers
  - Taps
- Unity Gain
  - Amplifiers
    - Maintenance Transponder

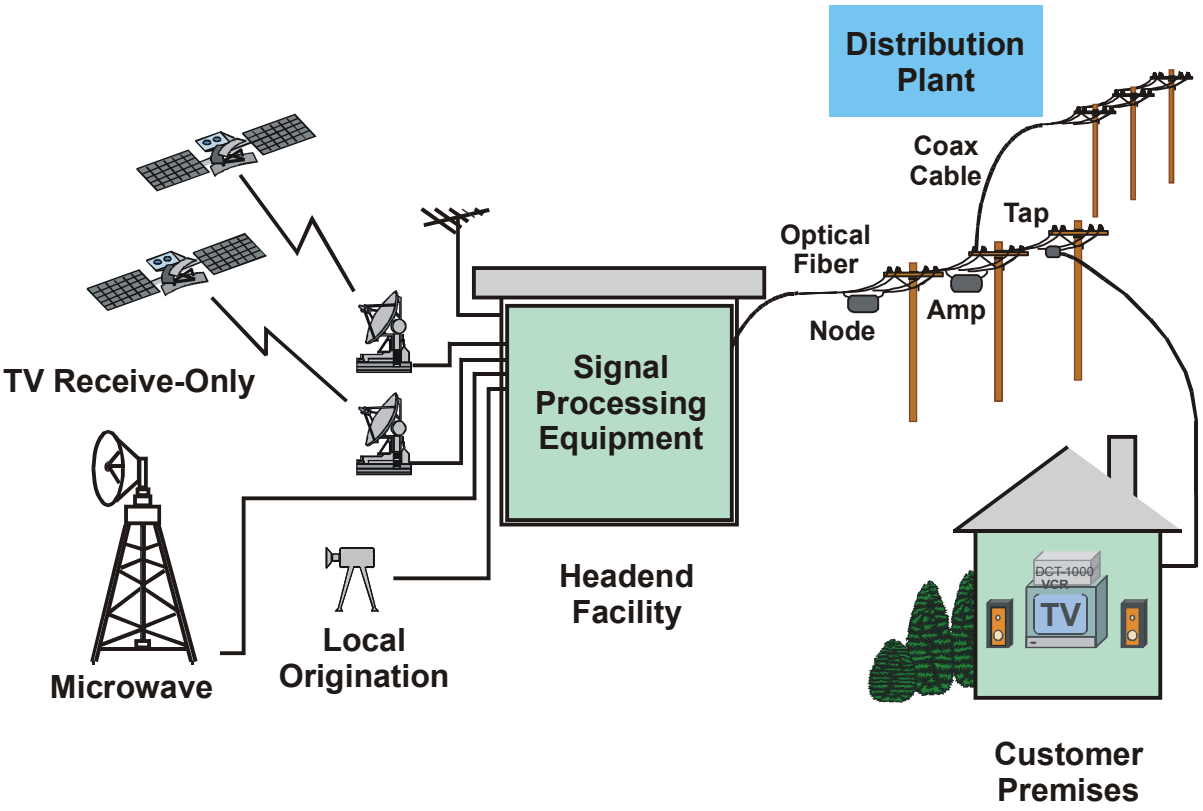



**Figure 5-1 Cable System Diagram, Broadband Communications Network**

## Fiber Node

The node is comprised of the optical receiver, node launch amplifier and return transmitter.

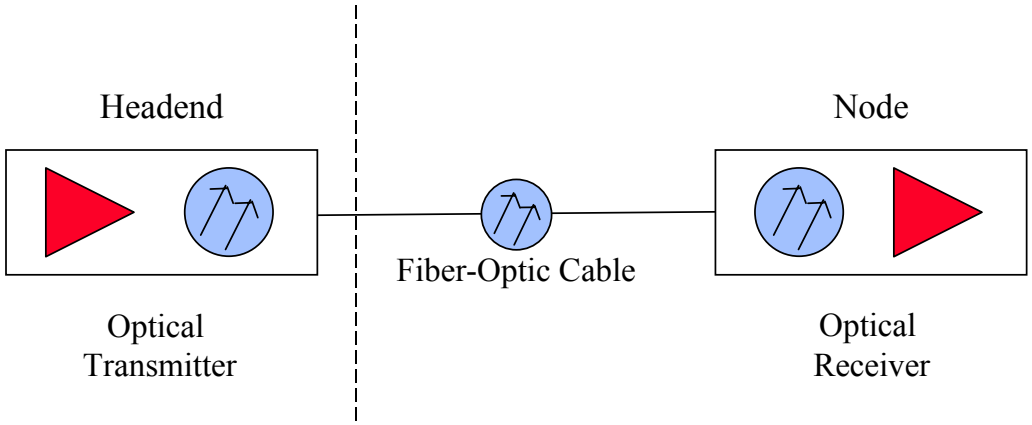



**Figure 5-2 Fiber-Optic Transmission Diagram**

## Power Supply

System Network Power is supplied on the coax by installing a 60-volt or 90-volt standby unit connected to the local power company service.

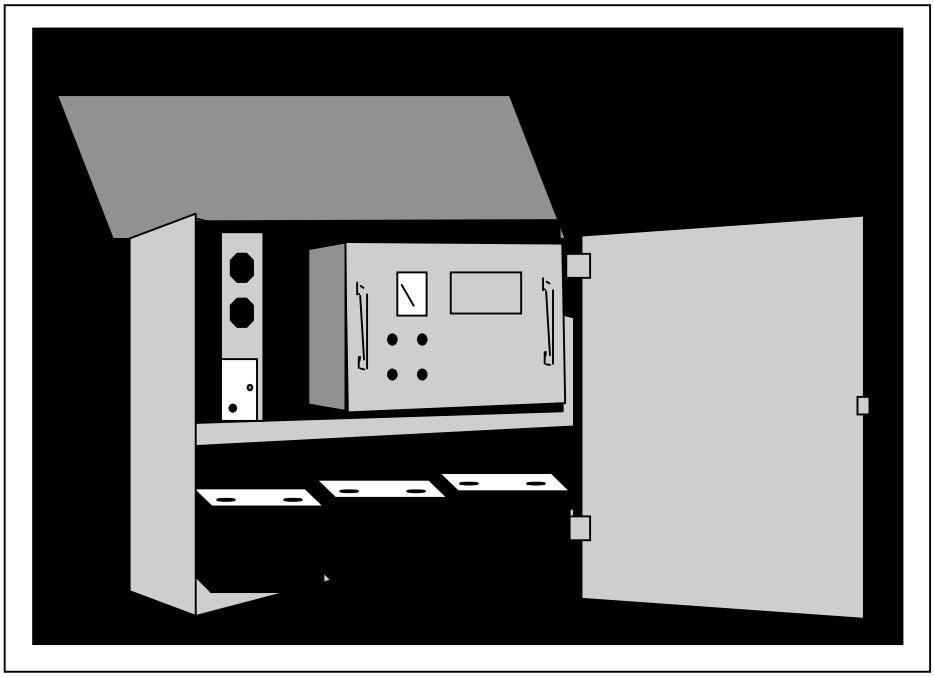


**Figure 5-3 Power Supply**

# Signal Transportation

## Coaxial Cables

Cable sizes utilized for trunk have sheath diameters of 1.25", 1.00", .875", .860", .750" or .715". A smaller size of cable is generally used for the feeder. The sheath sizes are typically as follows, .715", .625", .540", or .500".

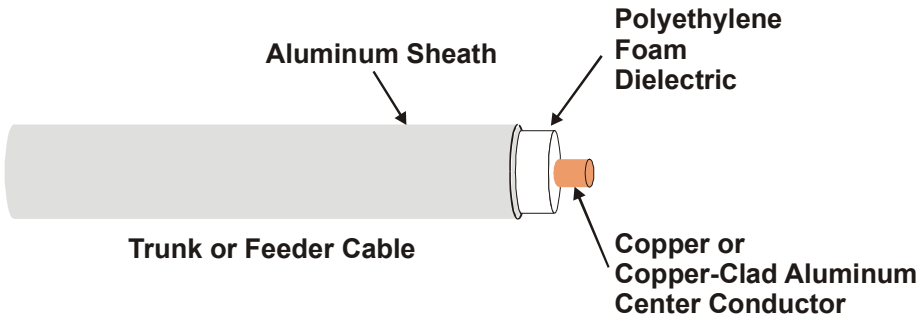



**Figure 5-4 Makeup of a Typical Coaxial Cable**

## Classes of Coaxial Cable

A coaxial cable (coax) is a type of cable that has two conductors sharing the same axis. It consists of a center conductor, insulating dielectric, conductive shield and optional protective covering.

- Trunk Cables/Express Cables
  - Typically 3/4" or greater in diameter.
  - Typically does not feed homes (taps).
  - Solid aluminum outer conductor.
- Distribution Cables
  - Typically 5/8" or less in diameter.
  - Tapped often.
  - Solid aluminum outer conductor.
- Drop Cables
  - Very flexible.
  - Small size.
  - Highest loss per unit length.
  - Today mostly size F6.

A coaxial cable also has:

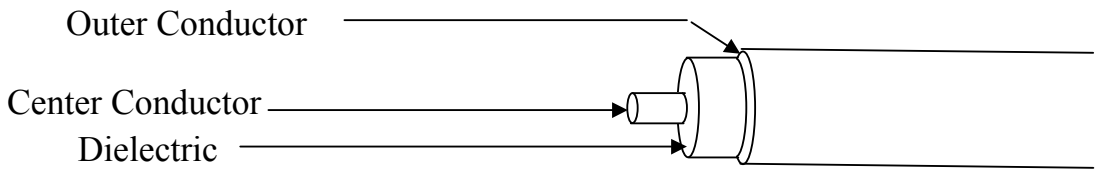
- 75 ohm impedance for maximum transmission of voltage.
- Bandwidth of 5 MHz to 1,000 MHz.
- Attenuation that increases with frequency and length.
- Structural return loss.
  - Trunk and distribution ≥ -30 dBc
  - Drop cables ≥ -20 dBc
- Loop resistance for trunk and distribution cables. (Affects ability to carry power.)
- Shielding efficiency.
  - Trunk and distribution ≥ 120 dB
  - Drop cables 70 to 110 dB

50 ohm coax is unacceptable for broadband use and testing of broadband components.

## Impedance

The characteristic impedance of coaxial cable is a function of the ratio of the diameters of the inner and outer conductors. The K factor is the dielectric constant of any dielectric material. The K factor for foamed dielectric is 1.285 and for air dielectric is 1.0.

- Maximum transfer voltage when Amp Z = Conn Z = Cable Z = 75 Ohms.
- Items Affecting Z:
  - Dents in outer conductor
  - Moisture around dielectric
  - Corrosion of either conductor
  - Temperature



The impedance (Z) of coaxial cable is calculated with the following equation:

$$Z = \frac{138}{\sqrt{K}} \times \text{Log}\left(\frac{D_o}{d_i}\right)$$

Where $d_i$ = diameter of inner conductor

$D_O$ = diameter over dielectric

K = dielectric constant

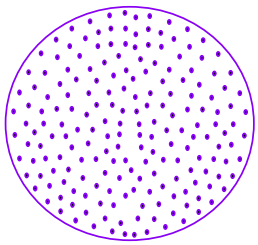
***Note:*** *The value of K is specified by the manufacturer.*

- Example: What is Z when $D_O$ = 0.349", di = 0.1" and K = 1.0?

$$Z = \frac{138}{\sqrt{1.0}} \times \text{Log}\left(\frac{0.349}{0.1}\right)$$
$$= 138 \times \text{Log}(3.49)$$
$$= 74.9 \text{ Ohms}$$

## Direct Current

In direct current applications, electron flow is energized throughout the entire conductor area. The larger the conductor, the larger the area for electron movement.



· -Electron

Conductor
Cross-Section

Electron flow in a conductor when direct current is applied.

**Figure 5-5 Direct Current Diagram**

## Alternating Current

When AC is applied to a conductor, more electrons flow through the conductor near the outer surface than through the center. The higher in frequency the alternating current is, the more of a "skin effect" is produced. The result of this phenomenon is a greater signal loss in relationship to the higher the frequency as the surface area for conductivity is reduced. For example, the signal loss for channel 116 (750 MHz) is over 4 times greater than the loss for channel 2 (55 MHz) passed through the same coaxial cable.

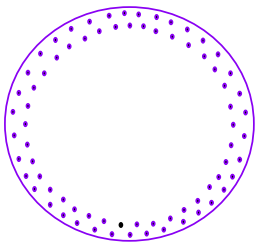
### Cable Loss Ratio

The ratio of cable attenuation at two frequencies is approximately equal to the square root of the ratio of the two frequencies.

$$\text{Cable Loss Ratio} = \sqrt{\frac{f_1}{f_2}}$$

For example, to calculate the approximate cable loss at 55 MHz when the loss at 450 MHz is 20 dB:

$$\text{Attenuation at 55 MHz} = \sqrt{\frac{55\ \text{MHz}}{450\ \text{MHz}}} \times 20\ \text{dB}$$
$$= 6.99\ \text{dB}$$



· -Electron

Conductor
Cross-Section

Electron flow in a conductor when alternating current is applied.

**Figure 5-6 Alternating Current Diagram**

### Impedance

To reduce attenuation further requires larger coaxial cables with the characteristic impedance of 75 Ohms. This effectively increases the surface area and reduces "skin effect" transmission losses. Of course, larger cables means increased costs.

| Application | Impedance |
|---|---|
| Power carrying capacity | 30 Ω |
| Breakdown Voltage | 60 Ω |
| Attenuation. | 75 Ω |

**Figure 5-7 Ideal Coaxial Impedances**

## Passive Devices

### Line Splitters/Couplers

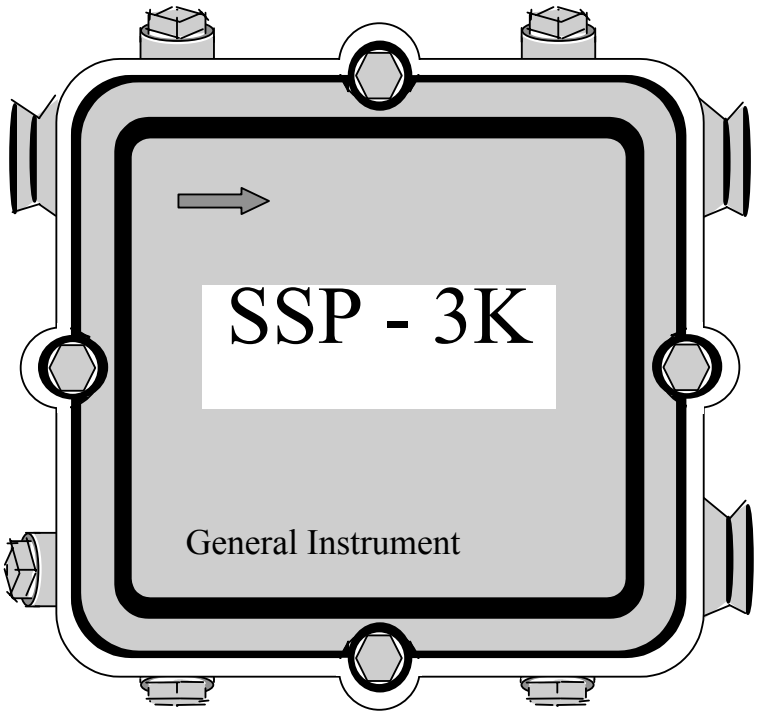



**Figure 5-8 Motorola 1 GHz SSP-K Series**

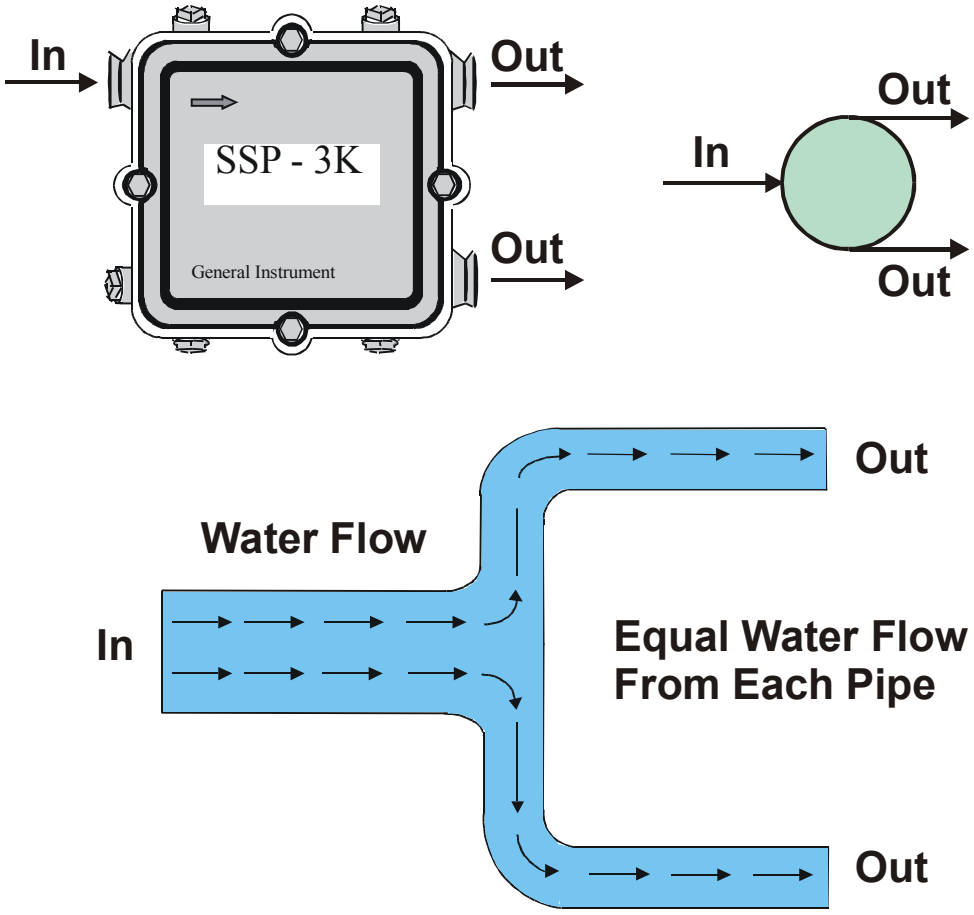



**Figure 5-9 Splitter Water Pipe Diagram**

A splitter is introduced into the cable system to feed divergent routes. Different value couplers are available to maximize system design.

- 2 way splitter
- 3 way splitter
- Directional Coupler DC-7
- Directional Coupler DC-9
- Directional Coupler DC-12
- Directional Coupler DC-16

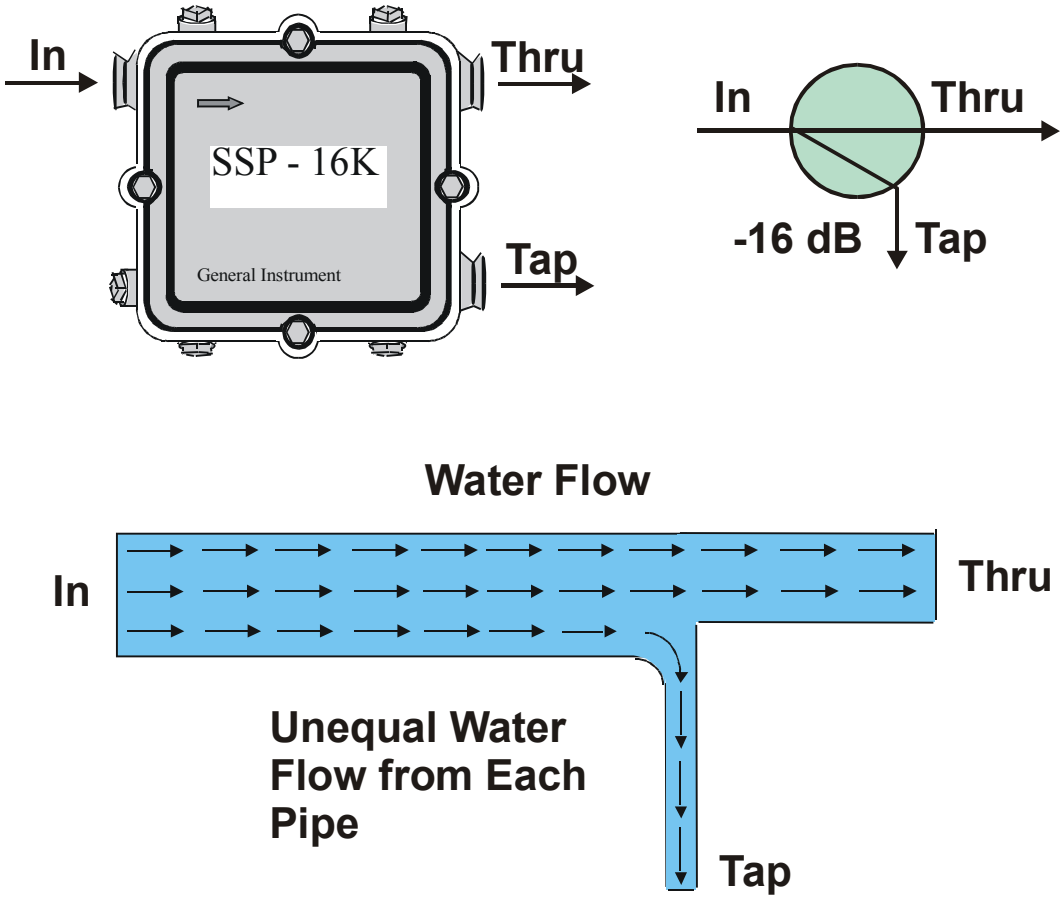



**Figure 5-10 Direction Coupler Water Pipe Diagram**

## Taps

Taps are directional coupler devices that provide signal for transport via drop cable to the customer Premises. Taps are available with two, four, and eight port configurations.

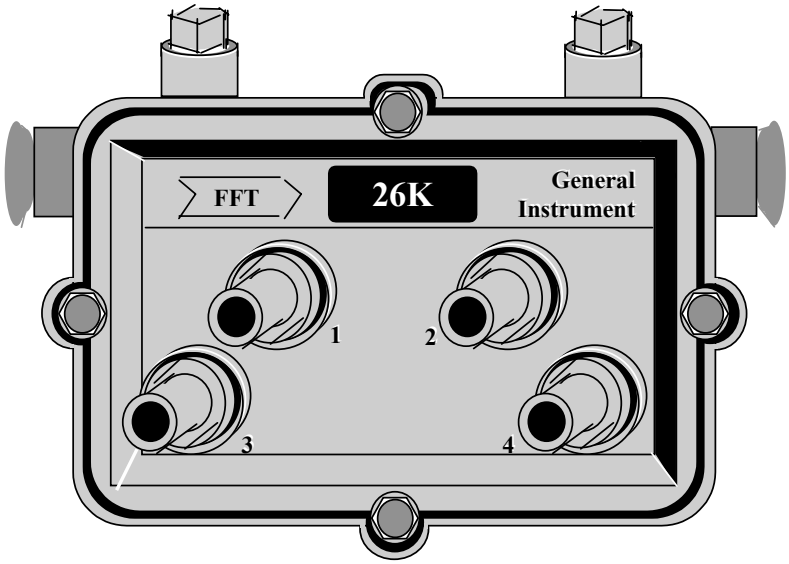



**Figure 5-11 Motorola 1 GHz FFT-K Series Full Feature Taps**

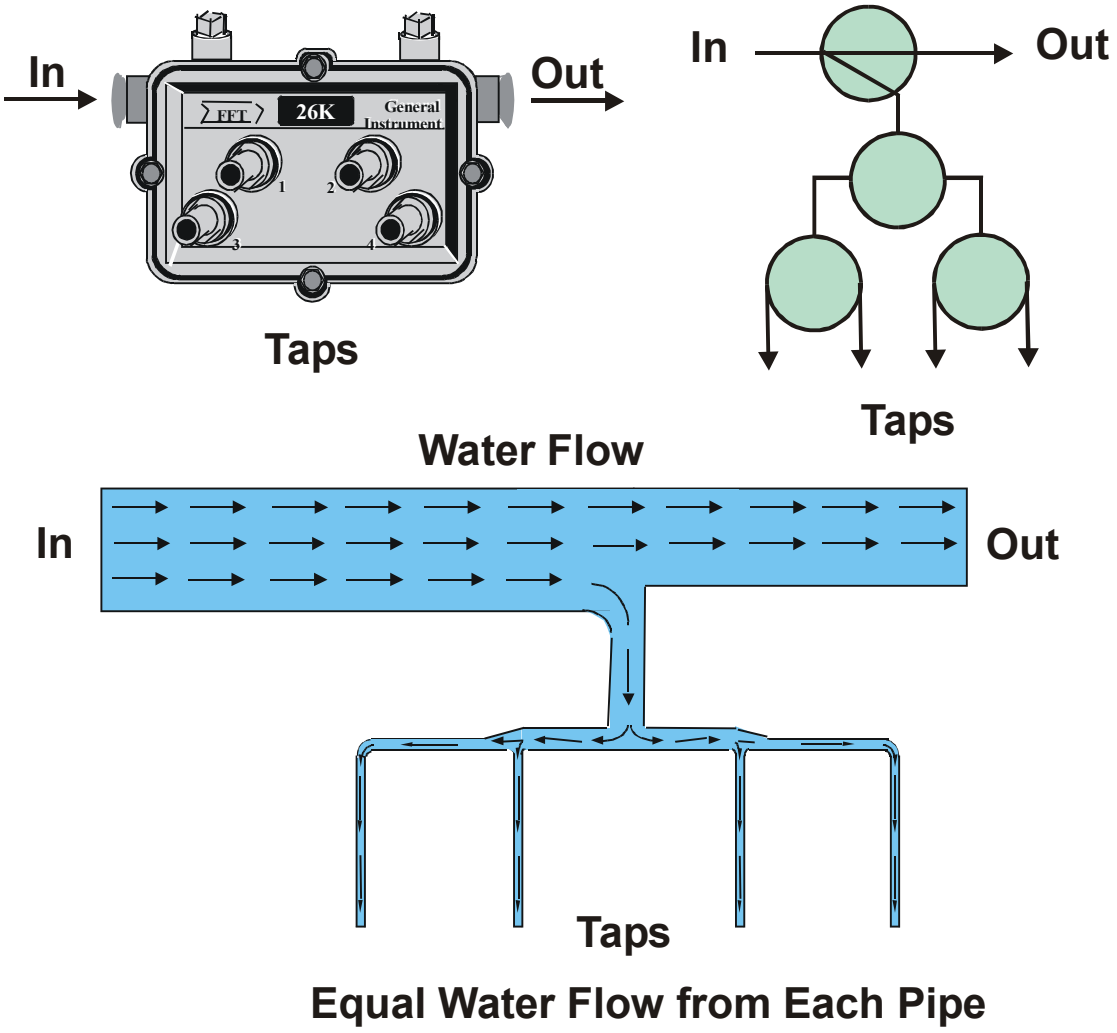



**Figure 5-12 Tap Water Pipe Diagram**

## Amplifiers

Amplifiers are used to maintain unity gain in the distribution system. This compensates for transmission losses that occur when signal levels fall below design standards predetermined to maintain network performance.

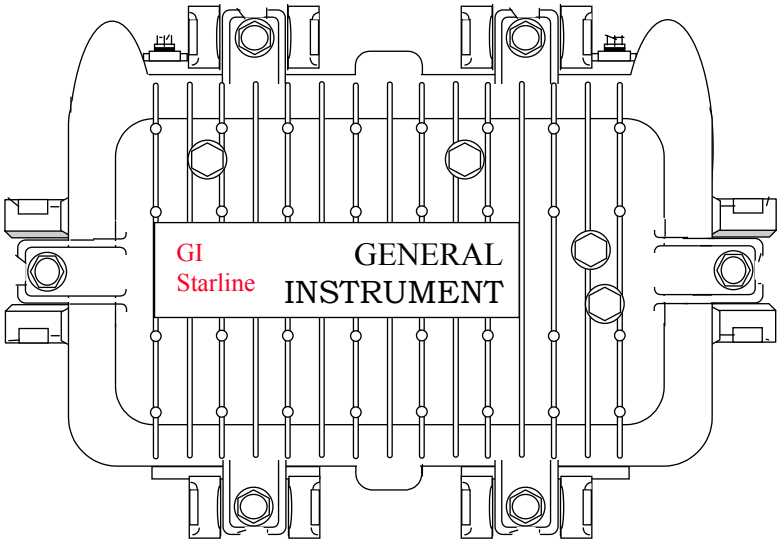



**Figure 5-13 Motorola MB 750 DH**

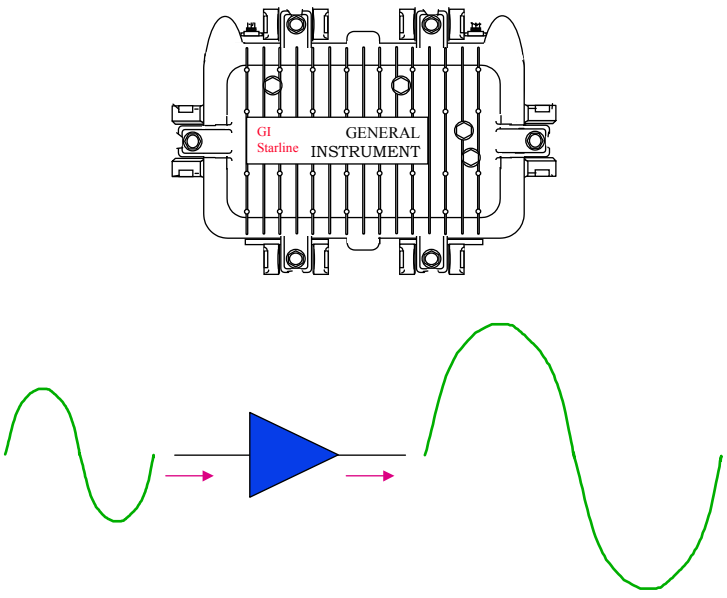



**Figure 5-14 Amplifier Diagram**

The signal flow in a basic amplifier is split by the diplex filter into two paths. The low signals (typically in the 5 to 40 MHz range) are routed from the output (customer side) of the amplifier, processed, amplified and recombined through a second diplex filter into the coaxial network. The high RF signals (50 to 750 MHz) flow in the opposite direction (input to output, headend side to coax feeding customers).

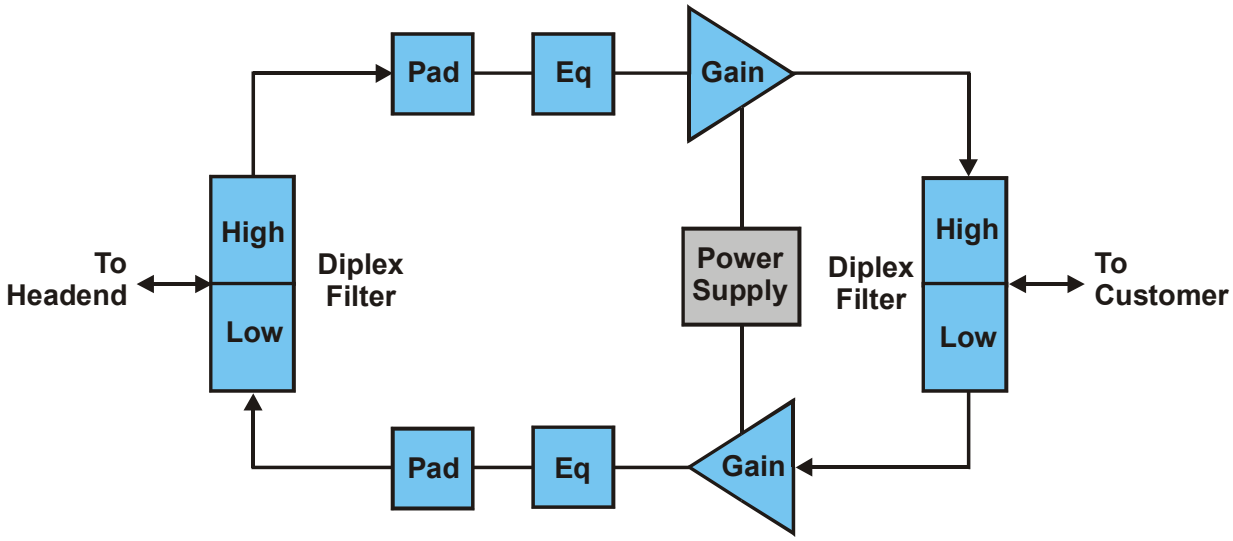



**Figure 5-15 Amplifier Block Diagram**

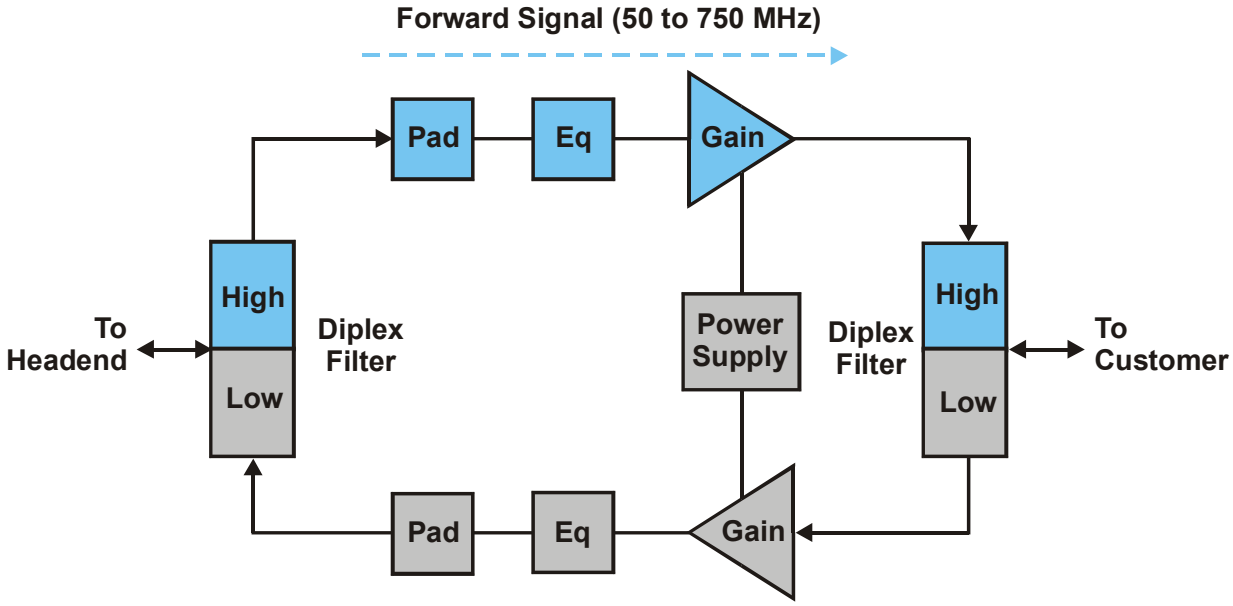



**Figure 5-16 Forward Signal Path Diagram**

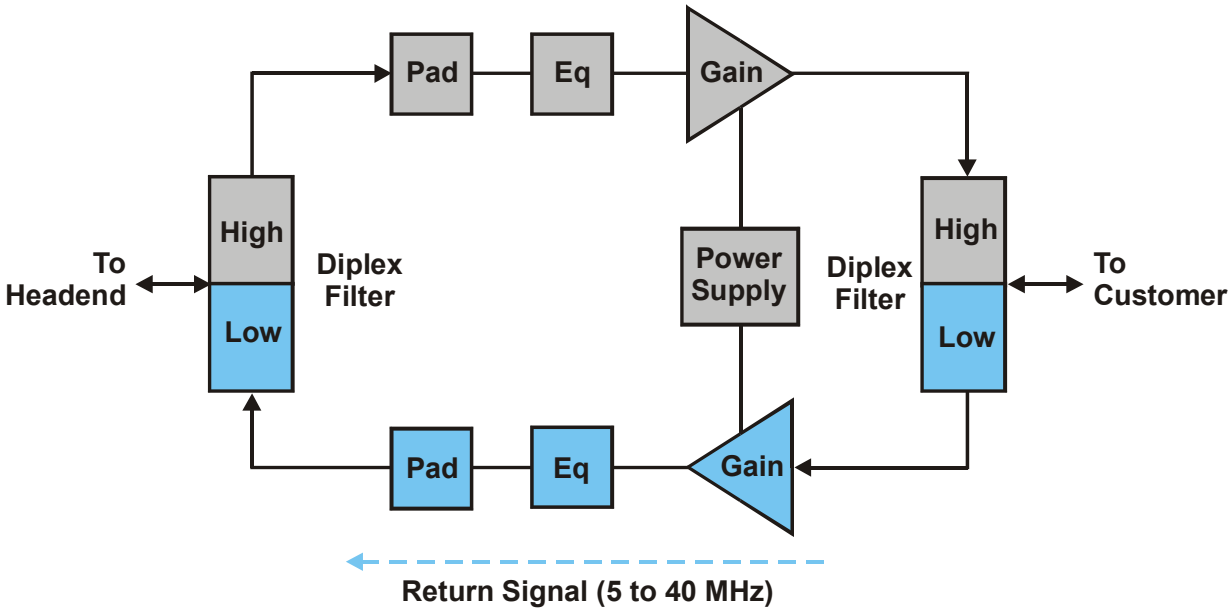



**Figure 5-17 Return Signal Path**

## Amplifier Processing

A fixed value pad (attenuator) is used to balance the amplifier for unity gain. If system design requirements state the input to an amplifier should be 20 dBmV (at the highest channel) and the field technician reads an input signal level of 22 dBmV, a 2 dB pad would be installed in the amplifier. An equalizer is used to compensate for the frequency response of the coaxial cable preceding the amplifier.

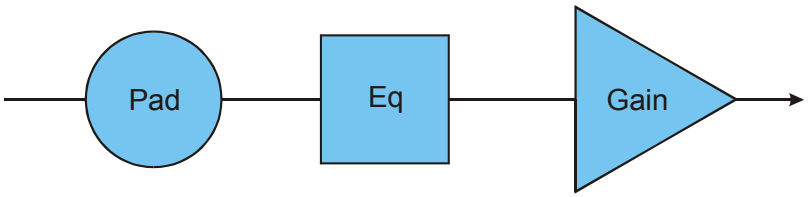



**Figure 5-18 Amplifier Processing Diagram**

## Automatic Gain Control

The Automatic Gain Control samples the signal level and adjusts the output of the gain stage using DC control voltages to maintain the desired signal output. This AGC action offsets temperature variations in the environment.

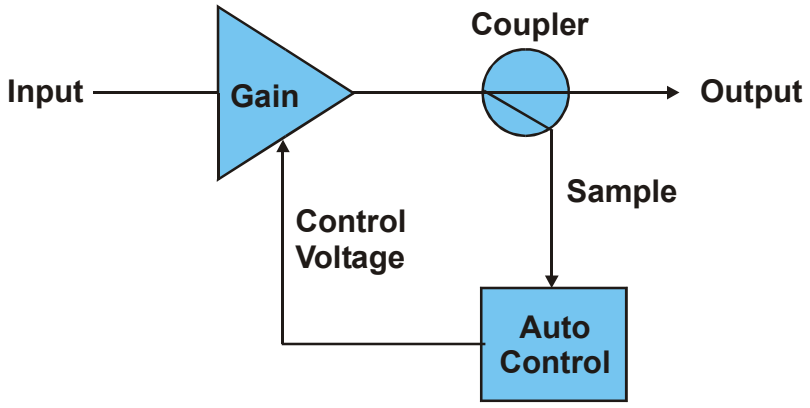



Figure 5-19 AGC Diagram

## Broadband Telecommunications Amplifier

Advanced telecommunications broadband amplifiers use power doubling technology with multiple signal outputs. Also a variable equalization flatness board is included to maintain a flat response over the entire 50 to 750 MHz spectrum. Thus the comparative levels at all channels can be adjusted in the field to compensate for impedance mismatches.

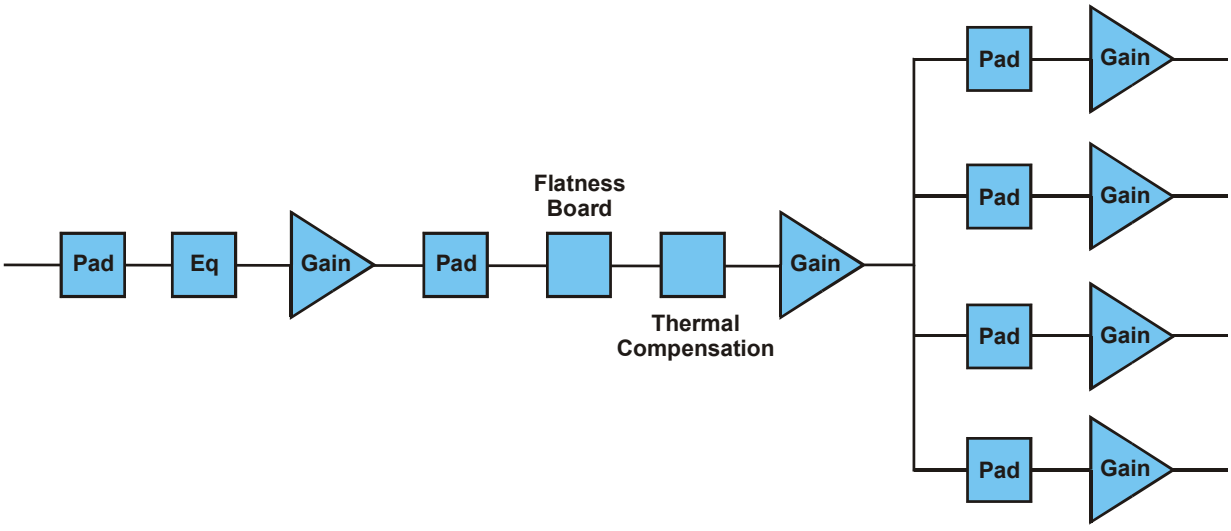



Figure 5-20 Broadband Amplifier Diagram

## Review

1 What are the four distribution system components?

2 What are the three parts of a fiber node?

3 Define coax or coaxial cable.

4 Name the three classes of coaxial cable.

5 Explain the term skin effect.

6 What is the function of a tap in the broadband network?

7 When is an amplifier needed in the broadband system?

8 What is AGC?

Section 6

# Customer Premises

When this section is completed you will be able to:

- Define the major components of the customer interface and explain their function.
- Identify the necessary equipment that is crucial to network operations.
- Understand the terms used to describe broadband communication.

# Customer Premises Components

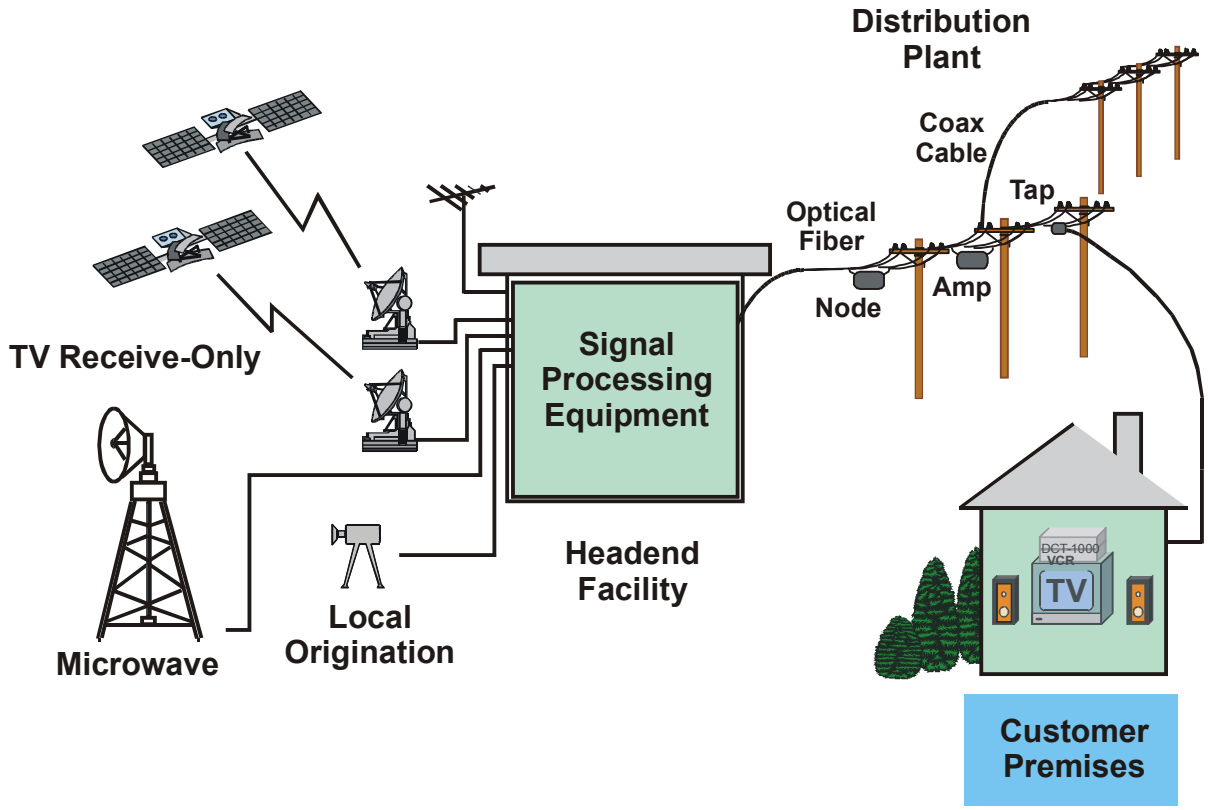



**Figure 6-1 Cable System Network Diagram**

## Premises Distribution

- Drop Cable
- Splitters
- Premises Amplifiers

## User Equipment

- Television
- VCR
- Computer
- Telephone
- Game Player

- CD Player
- Digital Audio

### Network Access

- Converters
  - Plain
  - Addressable

## Customer Drop Cable

The customer drop cable connects the feeder portion of the distribution system to the subscriber's home.

Drop cables to customer premises from tap ports are generally of two sizes.

1. F6 or F7 size cable is used inside the premises and for the tap-to-premises attachment when distances are less than 125 to 150 feet.
2. For greater distances from tap port to premises, a larger size F11 cable is utilized. This coax is also widely deployed in multi-dwelling units and commercial applications.

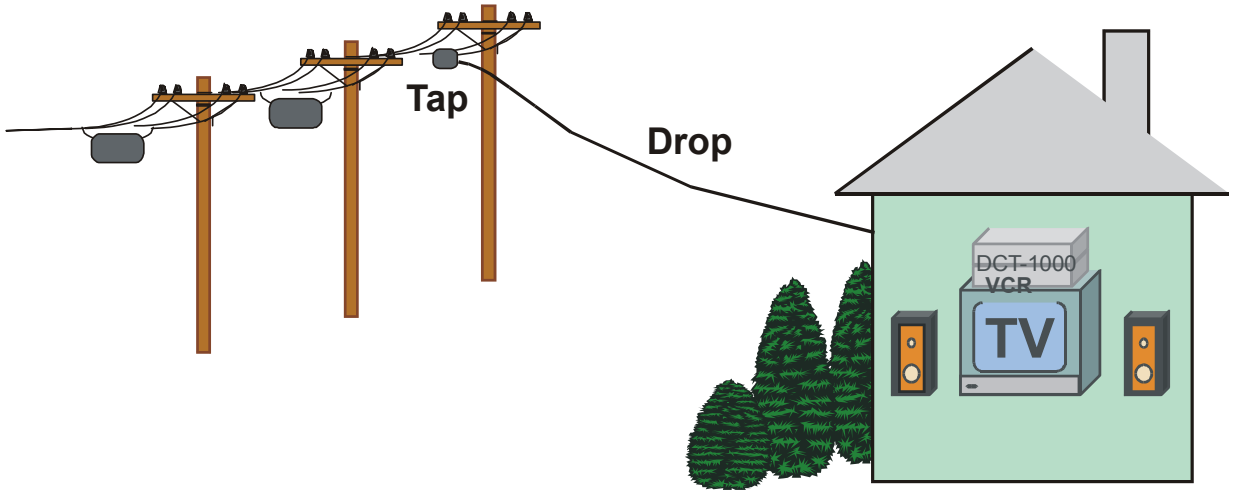



**Figure 6-2 Drop Cable Diagram**

## House Splitter

House splitters are used to provide multiple connections at customer premises. Note the lower Bonding Screw/Clamp at lower right.

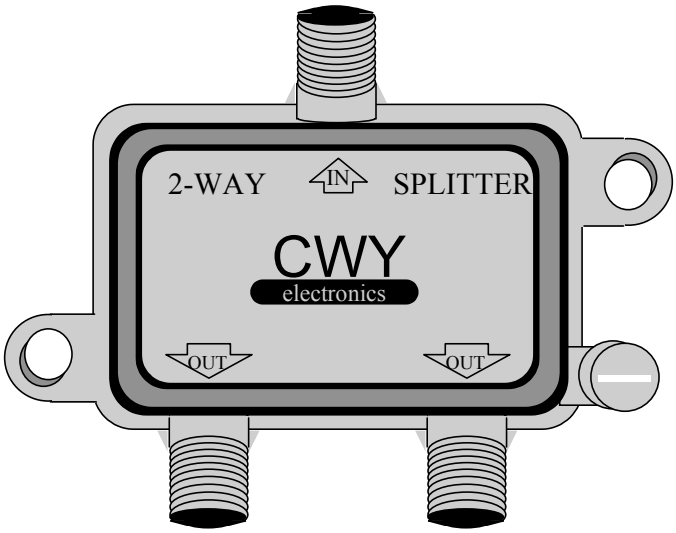



**Figure 6-3 House Splitter**

## Plain Converters

Converters allow customers to select channels not available to them on older television sets (those selecting only channels 2 to 13 VHF, and UHF). Additional features include channel 2/3 output, volume control, parental control of channel viewing, favorite channel programming, BTSC stereo outputs, and remote control.

***Note:*** *BTSC is the defacto multichannel television sound standard adopted by the Broadcast Television Systems Committee for stereo audio television broadcast.*

## Addressable Converters

Addressable converters allow system operators to control access to individual channels at customer premises. The converter commands are sent to the unit on FSK modulated carriers in the FM Band (88 to 108 MHz). The units come in two versions, one way and two-way (return signal generator). The return signal can be routed over the network in the 5 to 40 MHz spectrum or via telephone line.

Methods of Addressable Security include suppression of the horizontal sync and video inversion.

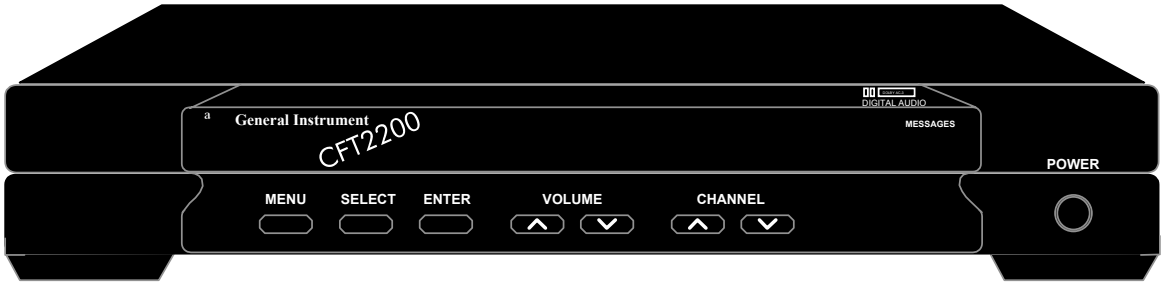



**Figure 6-4 Motorola Impulse 7000 Series CFT220, Interactive Capable Baseband Addressable Terminal**

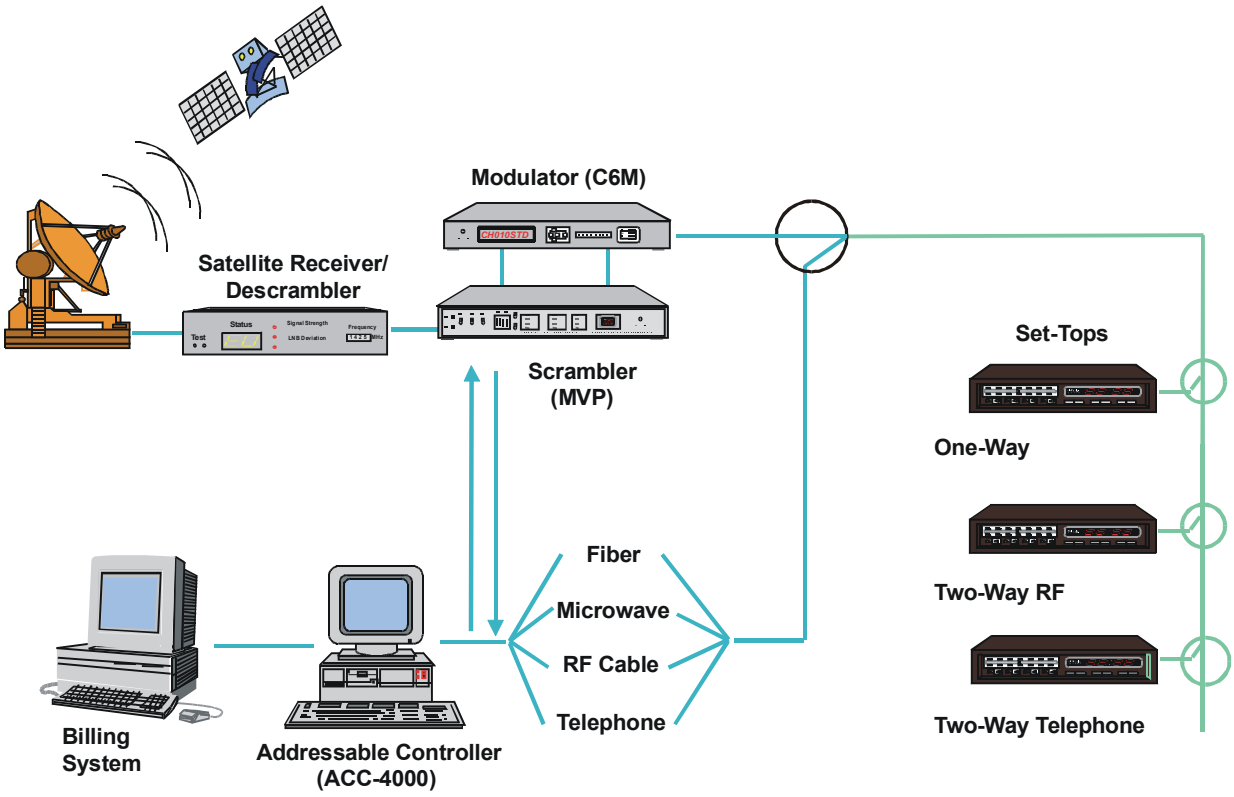



**Figure 6-5 Addressable Controller Flow Diagram**

## Addressable Services

The Addressable Converter allows the programming of services to individual users.

- HBO
- Showtime
- PRISM
- ESPN
- History Channel
- The Movie Channel
- Encore
- Court TV
- Playboy
- Home & Garden
- Pay-Per-View
- And Many More...

## FM Splitter

Connecting a FM splitter to the network allows the FM radio band (88 to 108 MHz) to be directly inputted into a stereo receiver.

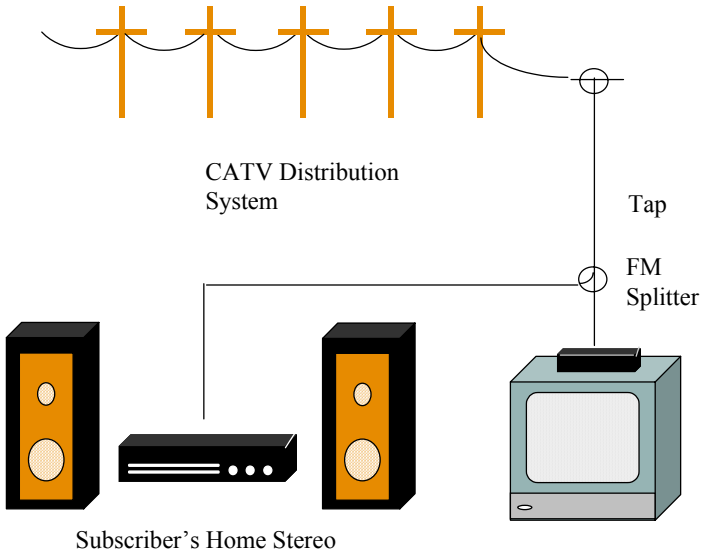



**Figure 6-6 FM Splitter Distribution Diagram**

The FM splitter is not to be installed in networks with FM data carriers used as control signals for set top converters.

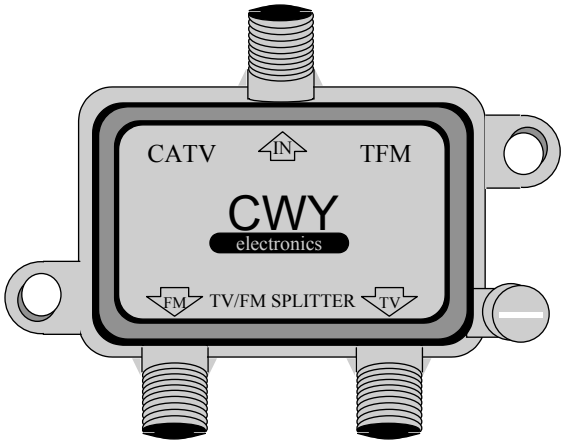



**Figure 6-7 FM Splitter**

# Music Choice

Addressable technology enables CD-quality digital audio to be supported on the network. The placement of the audio service is currently supported in 52 to 806 MHz range.

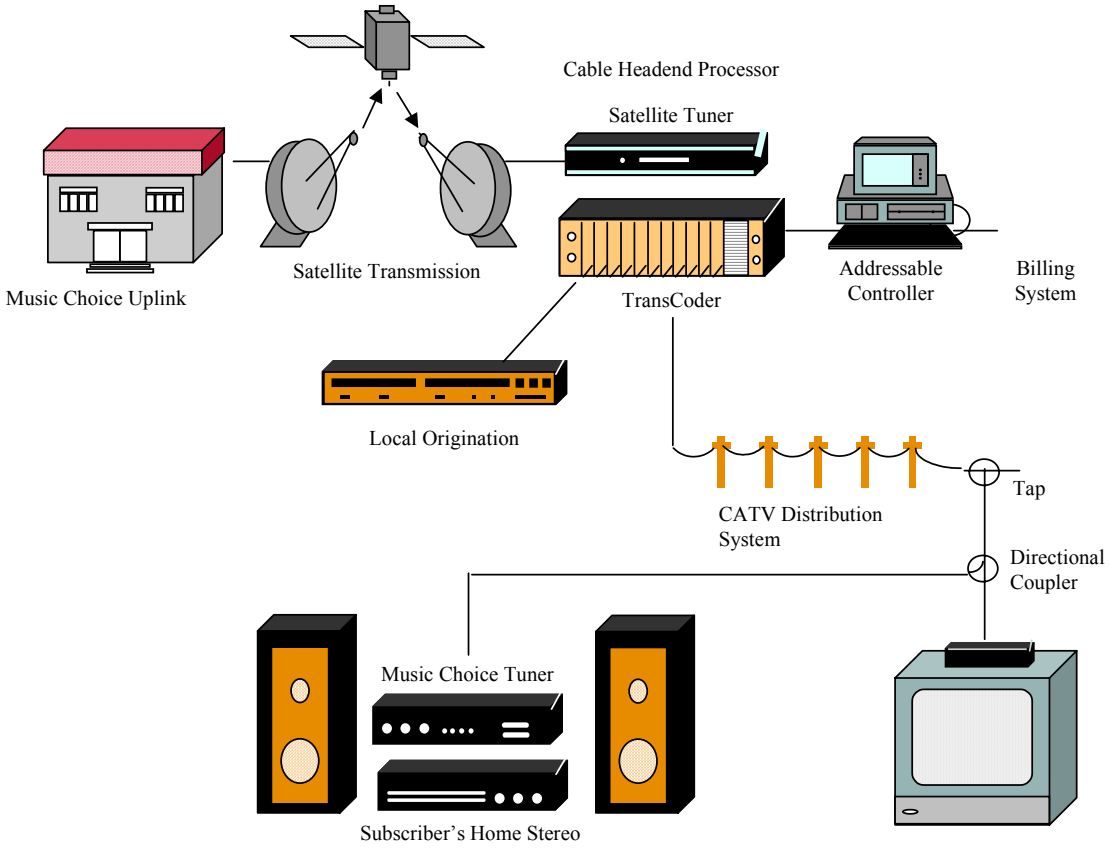



**Figure 6-8 Music Choice Flow Diagram**

## Review

1 Name the three major components of customer premises.

_____

_____

_____

2 What device provides multiple connections at the customer premises?

_____

3 What is the “BTSC”?

_____

_____

4 What is the difference between a plain converter and an addressable converter?

_____

_____

5 Name three addressable services.

_____

_____

_____

6 What is the operational bandwidth widely used in a broadband network?

_____

_____

Section 7

# Network Architecture

After completing this section of the course, you will be able to:

- Identify CATV architectures (broadband networks).
- Identify different architectures based upon serving area size.

## Tree and Branch

Tree and branch is the original CATV architecture. Long trunk amplifier cascades characterize systems built with this architecture. Tree and branch is suited for video services, but has limited 2-way capabilities. Only a very small percentage of new system construction uses this architecture.

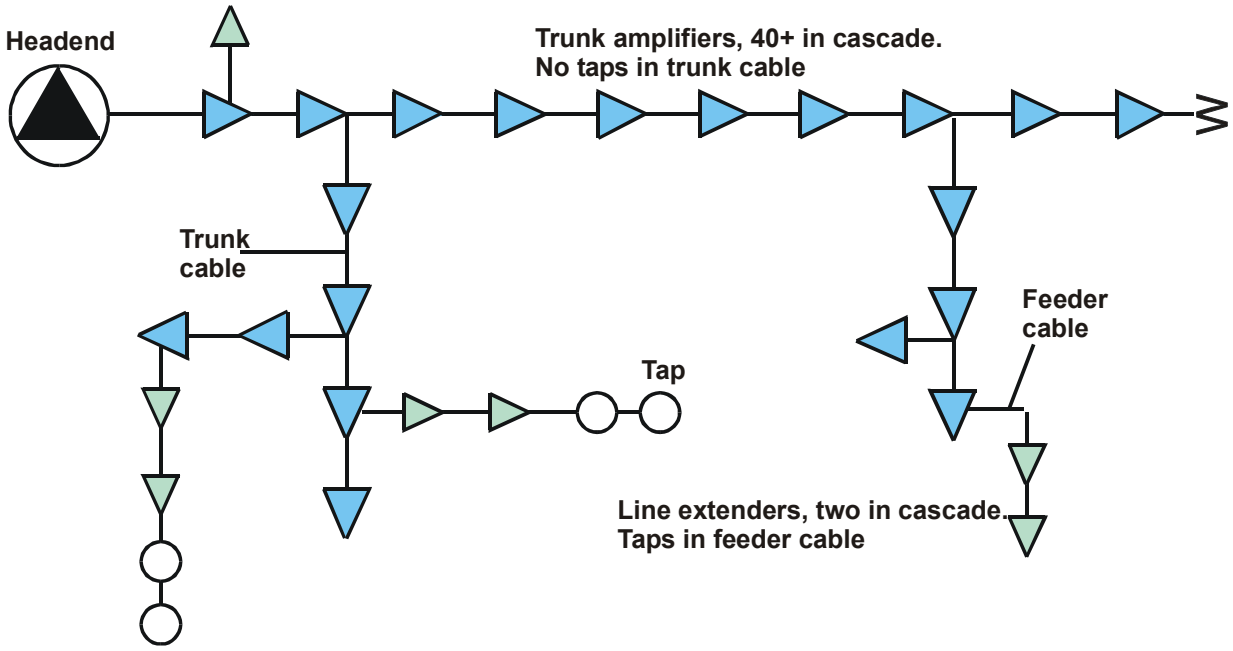



**Figure 7-1 Tree and Branch Architecture**

## Fiber Backbone

This was the initial method of fiber deployment. Nodes were placed to segment the network into smaller serving areas (5,00 to 10,000 homes per node) and to reduce amplifier cascades, improving system performance. Fiber backbone also improves return system performance and capacity. Only a very small percentage of new system construction uses this architecture.

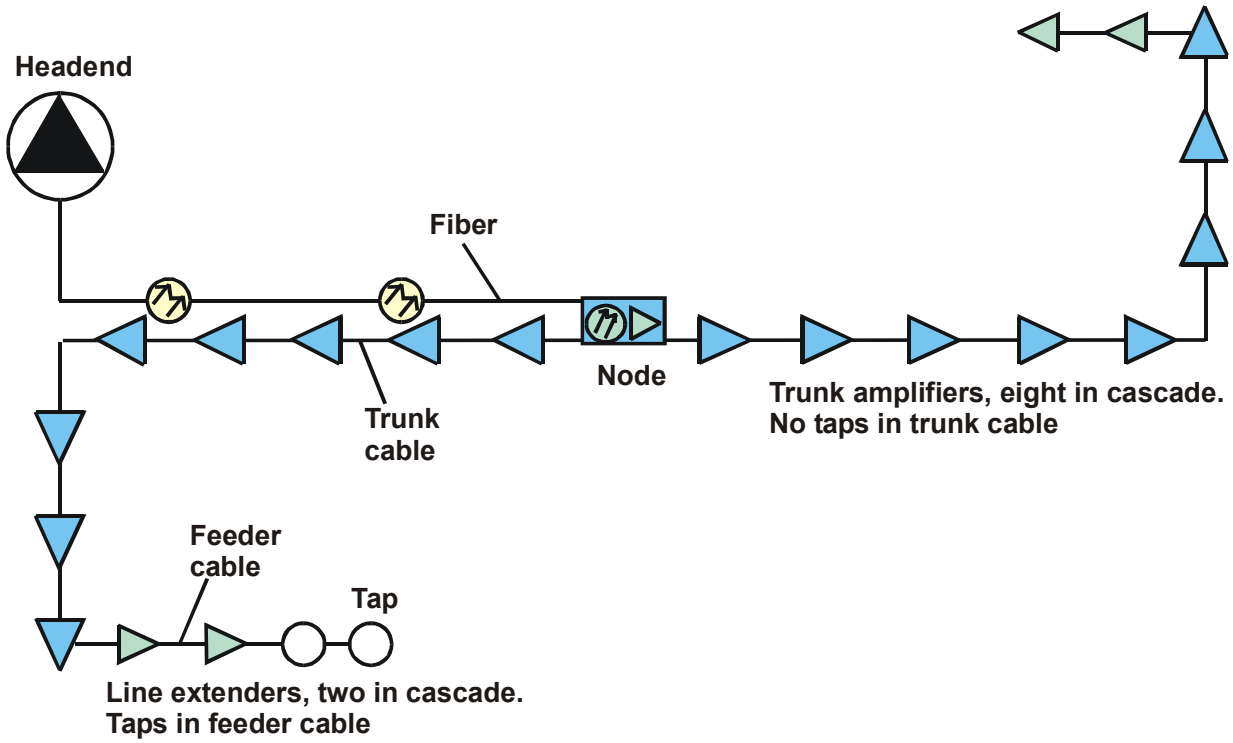



**Figure 7-2 Fiber Backbone Architecture**

## Hybrid Fiber Coax (HFC)

This is currently the most used network architecture. With this architecture, fiber is carried deeper into the network, serving 125 to 2,000 homes per node. HFC reduces amplifier cascades to improve performance, reliability, and cost. Return system performance is capacity is greatly improved, and the flexibility of HFC makes it well suited for video. Voice. Data, and interactive services.

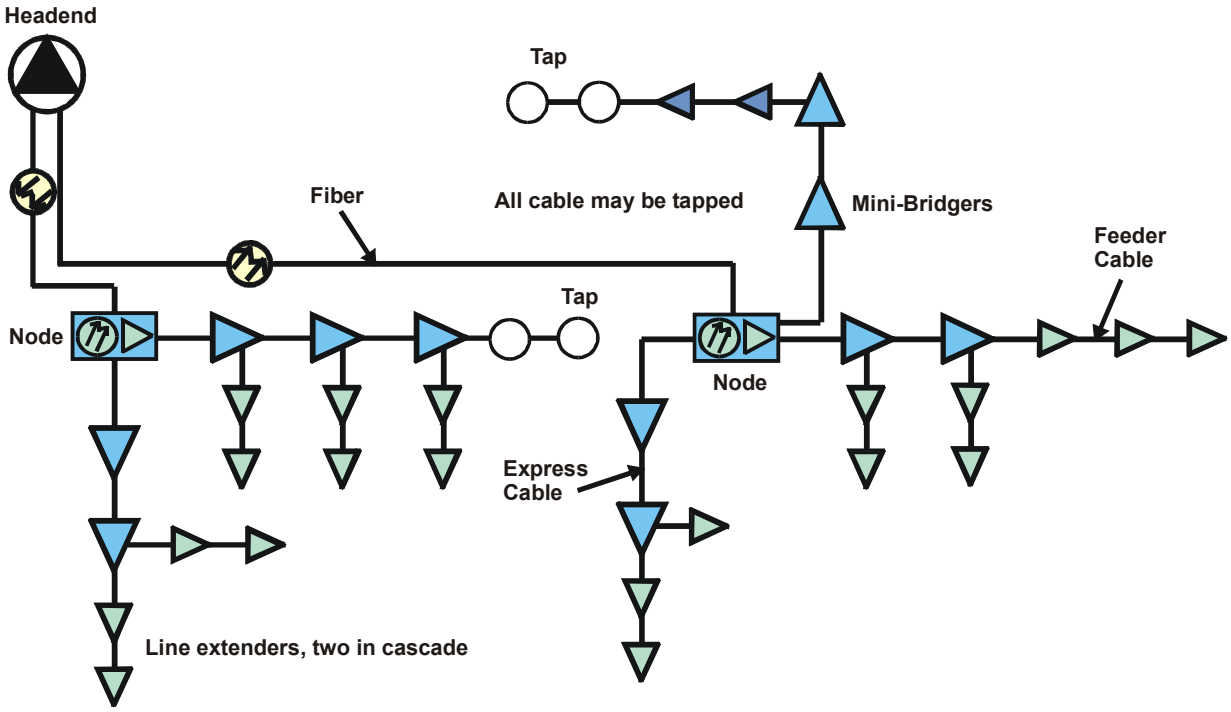



**Figure 7-3 Hybrid Fiber Coax Architecture**

Section 8

# Evolution to Digital

After completing this section of the course, you will have an understanding of:

- The basics of digital signals
- Analog-to-digital conversion
- Digital compression
- Digital signal processing

## What is a Digital Signal

A digital signal can be in one of two states, one representing a 1 and the other a 0. To make an analogy with a light switch: the switch on is 1 and the switch off is 0.

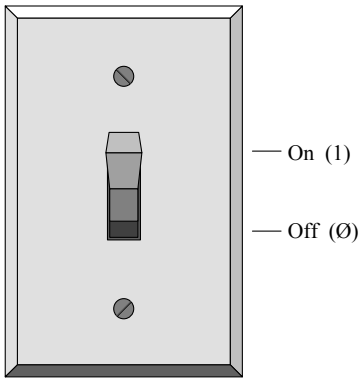



**Figure 8-1 Light Switch Analogy**

## Binary Numbers

Binary numbering is to the base 2. Each position in a binary word represents a corresponding decimal value. For an 8-bit word the form is like this:

| $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|---|---|---|---|---|---|---|---|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Some examples:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | = 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | = 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | = 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | = 3 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | = 20 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | = 255 |

## Exercise

What decimal values do the following 8-bits words have?

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | = ___ |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | = ___ |
| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | = ___ |
| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | = ___ |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | = ___ |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | = ___ |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | = ___ |

# Digital Video

## Analog to Digital Conversion

### Sampling

Digitization is achieved by sampling the analog signal's amplitude, then assigning a digital value.

- The wider an analog signal's bandwidth, the more samples must be taken.
- The NYQUIST sampling rate is the minimum sampling rate equal to twice the highest frequency present to be sampled.
- If NYQUIST sampling rates are used all of the information in the analog signal can be recovered.

### Quantizing

The samples of the analog signal are assigned discrete digital values.

- An 8-bit word can represent 256 discrete values.
- Each sample is assigned one of the 256 discrete values.

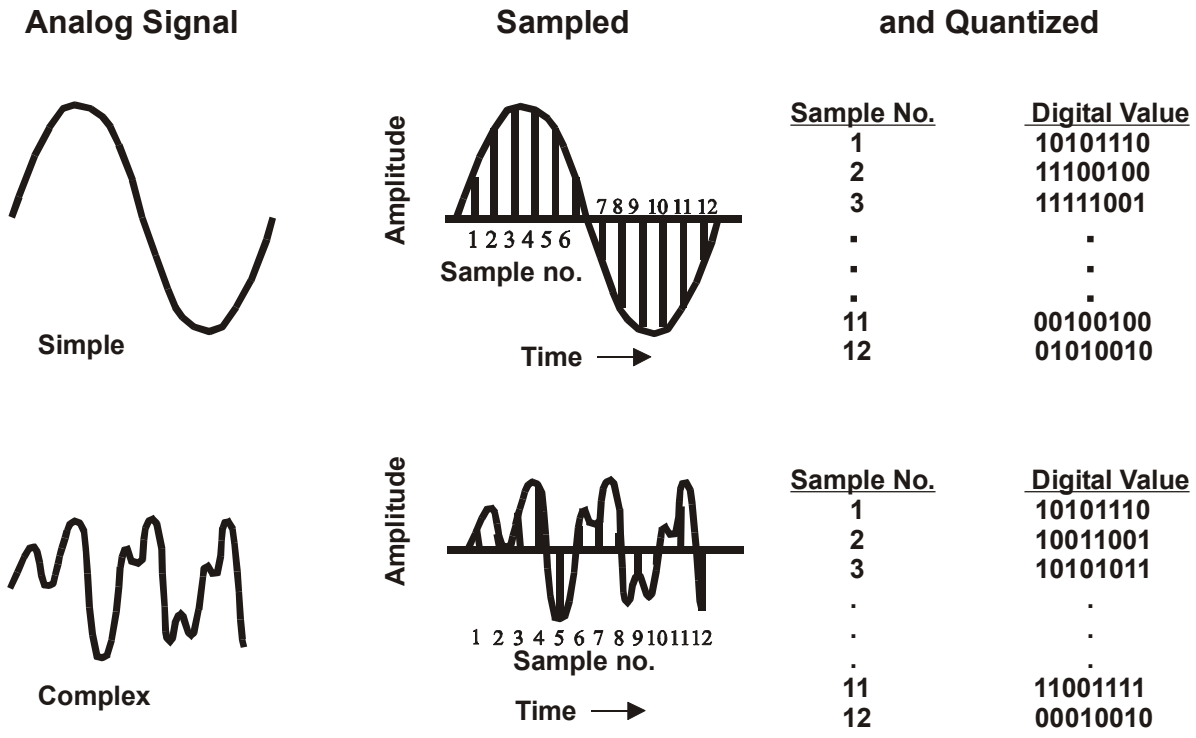



**Figure 8-2 Analog to Digital Conversion**

## Sampling Rate

The minimum sampling rate to reproduce the original analog signal is called the Nyquist sampling rate. This rate is twice the highest frequency sampled. For example, if the highest frequency to be sampled is 10 MHz, then the minimum sample rate is 20 MHz.

If the sampling rate is too low, the signal may be severely distorted by the effect called aliasing. The following figure shows the effect of low sampling rate.

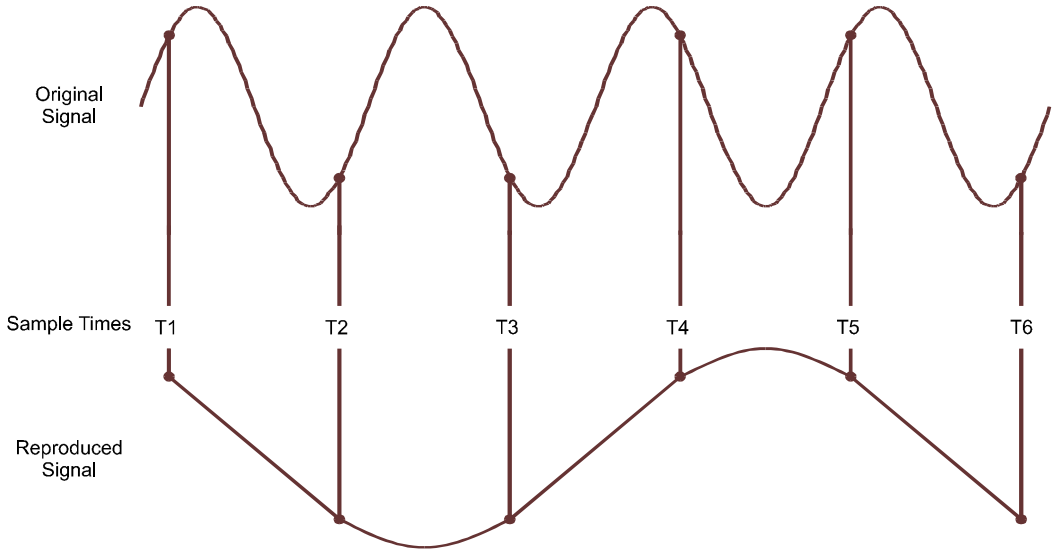



**Figure 8-3 Effect of Low Sampling Rate**

## Errors in Quantization

Errors occur in quantization when the number of levels is insufficient and the signal level falls between any two assigned values. Signal noise can also cause misrepresentation of actual levels.

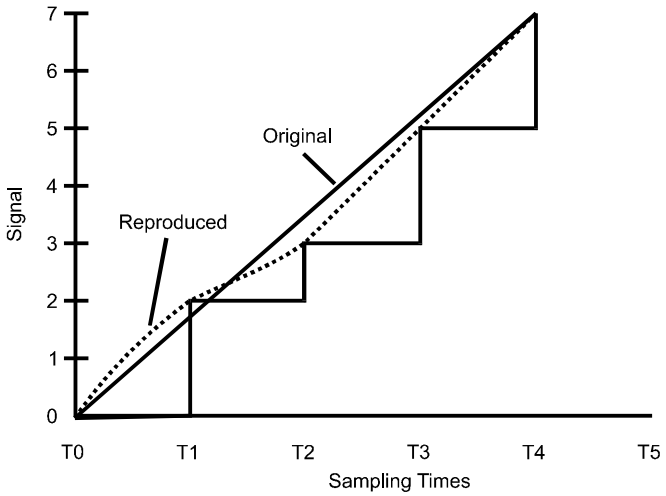



**Figure 8-4 Quantization Errors**

## Digital Compression

Digital compression is the process of reducing storage space and/or transmission data rate necessary to store or transmit information that is represented in a digital format.

Common digital compression methods include the suppression of long strings of 1s or 0s, delta transmission (only sending information about the difference between signals sampled at two successive periods of time) and, for video applications, matching the characteristics of picture quality to the limitations of the human eye.

- Analog signal voltages are sampled periodically.
- Signals are converted into bits (1, 0). The bits correspond to a particular voltage in time.
- These bits are compressed into a small spectrum using a complex mathematical algorithm.
- With digital compression, up to 14 analog channels can be inserted in one 6 MHz bandwidth, depending on the compression ratio.
- The bandwidth of the video information in a NTSC analog channel is 4.2 MHz.
- The Nyquist bandwidth is 4.2 MHz x 2 = 8.4 MHz. The practical sampling rate (worldwide standard CCIR 601) is 13.5 MHz.
- The total sampling rate of one digitized analog video signal is 13.5 MHz x 8 bits/sample = 108Mbps. At 1 bit/Hz, this bandwidth is the equivalent of 18 uncompressed analog channels in one 6 MHz bandwidth.

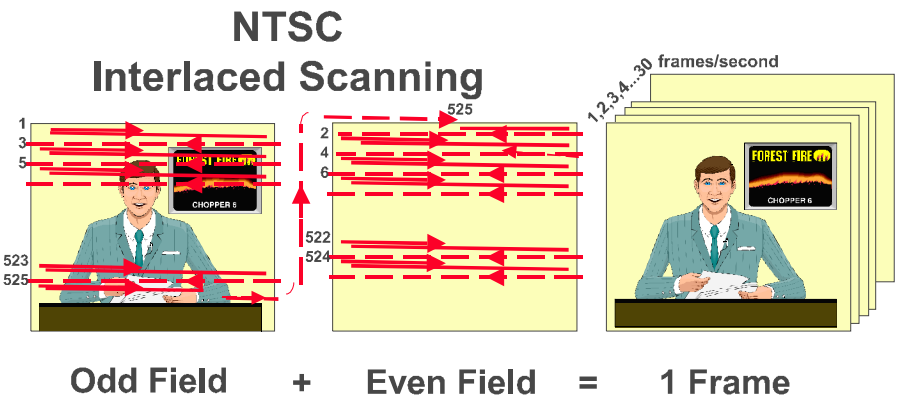



**Figure 8-5 Anatomy of a Television Picture**

## Video Compression Basics

- Small areas of each frame have similar image, color, and intensity.
- Small areas of successive frames are similar but displaced.
- Efficient data processing techniques can significantly reduce the amount of transmitted information.

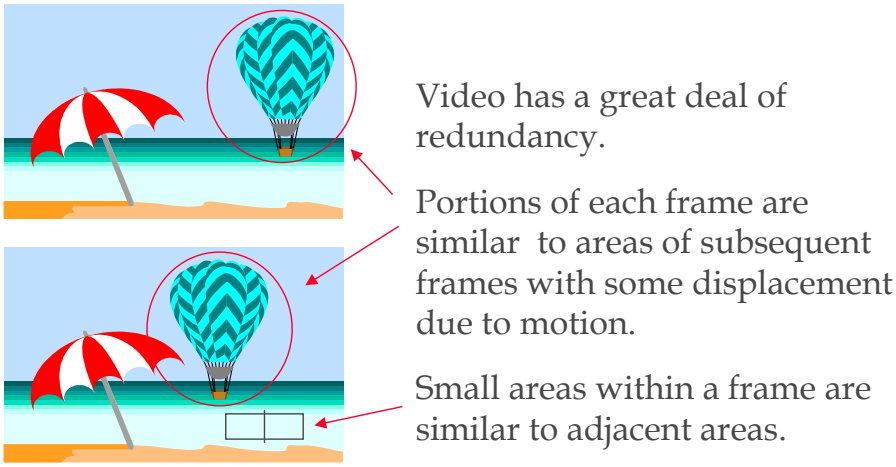

Video has a great deal of redundancy.
Portions of each frame are similar to areas of subsequent frames with some displacement due to motion.
Small areas within a frame are similar to adjacent areas.

**Figure 8-6 Video Compression Basics**

### Video Compression Steps

1. Apply motion estimation technology to transmit only the data that changes from one frame to another.
2. Apply the DCT (Discrete Cosine Transform).
3. Quantize DCT coefficients to represent small areas of picture with a minimum amount of data.
4. Huffman (or statistically code) results to transmit bit patterns that occur frequently with fewer bits. (This process is similar to WINZIP performance in computer file compression.)

### Video Compression Techniques

Motion compensation improves accuracy of predictive coding, where digital video is divided into blocks of 16 x 16 pixels (called macroblocks) and analyzed for patterns of movement. The patterns are represented by motion vectors that require less data than sending a macroblock. This technique is considered lossy.

- Intra-frame techniques
  - Spatial compression
  - Temporal compression
- Run-length coding

### Spatial Compression

The spatial compression technique eliminates redundancy within the frame by using Discrete Cosine Transform (DCT) to compare adjacent pixels. Video is divided into small blocks of 8 x 8 pixels.

Spatial compression works best when there is a significant amount of similarity between pixels and between macroblocks (e.g., blue sky), however it is considered lossy.

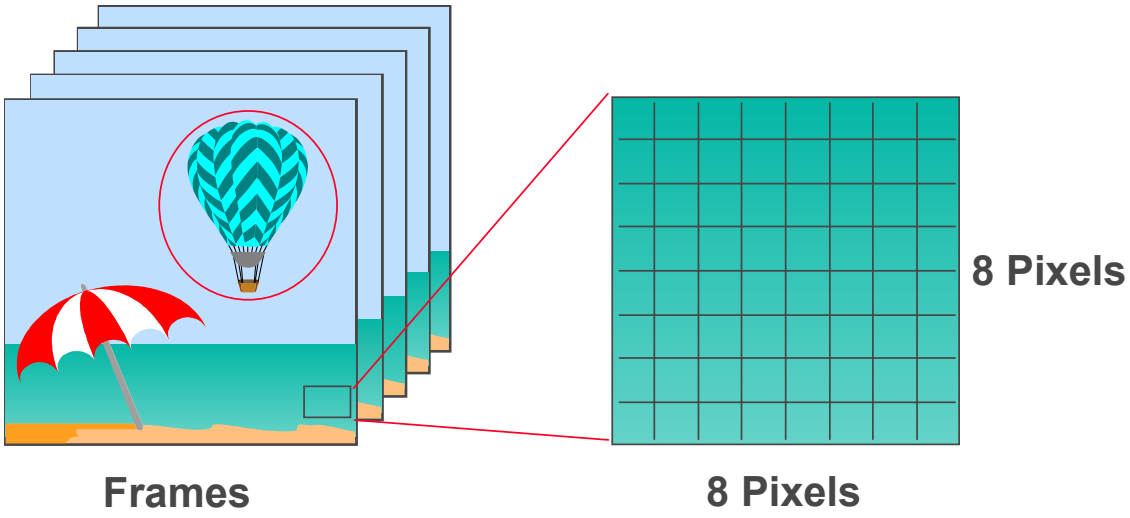



**Figure 8-7 Spatial Compression Diagram**

### Temporal Compression

Temporal Compression -- This technique eliminates redundancy between frames of video. On average, only 10% of data change from one frame to the next.

Predictive Coding -- Both the encoder and the decoder use other frames of video to predict the next frame. Instead of sending the actual frame, the encoder transmits only the difference between the actual and predicted frames.

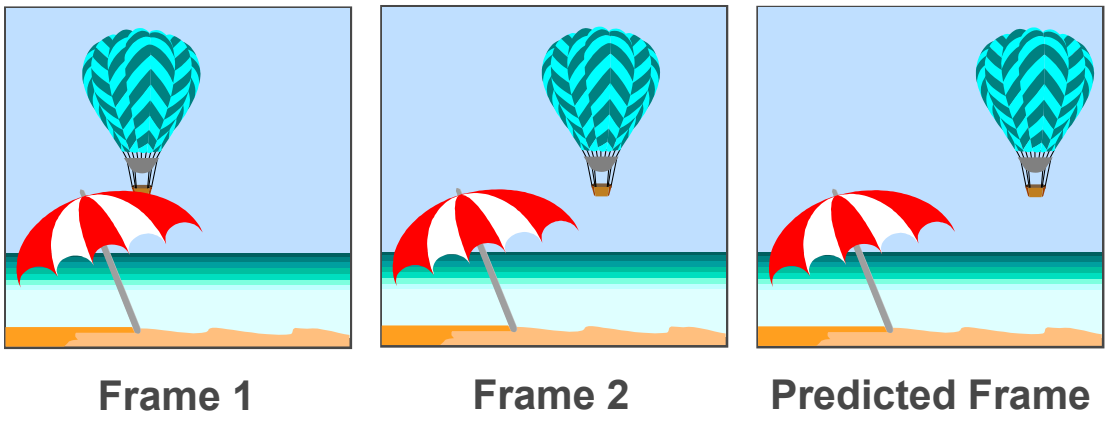



**Figure 8-8 Predictive Coding Diagram**

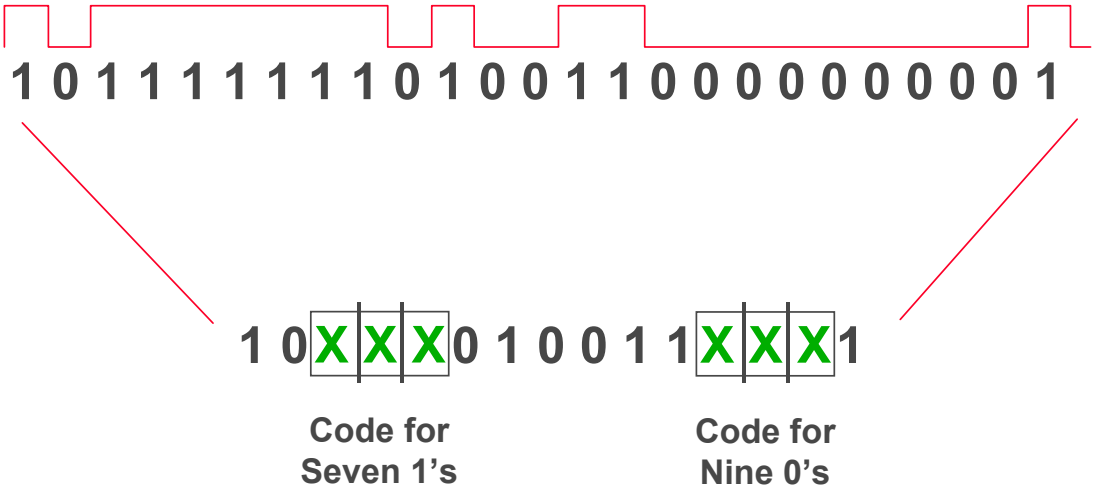



**Figure 8-9 Run-Length Coding Diagram**

### Lossy vs. Lossless Methods

Different methods of digital video compression are described as either lossy or lossless.

- Lossy methods discard unnecessary information.
  - Fine detail or high frequency information.
  - Chrominance (color) information.
- Lossless methods compress data efficiently.
  - All original data can be recovered.

# Error Detection and Correction

Digital signal quality degrades due to random noise, impulse noise, and intermittent interruptions as it moves from the transmitter location to the receiver location.

Forward Error Correction (FEC) technology is applied to the data stream after digitization and compression.

## Reed-Solomon (R-S)

Block-type error protection encoding that has a high data rate with low parity bit overhead. Provides good burst error correction with the capability of correcting a large number of errors within a byte.

Reduces usable data (payload) of the channel because the parity bits used for error detection and correction must be transmitted.

## Trellis-Coded Modulation (TCM)

A type of coding used with digital modulation that allows errors to be detected and corrected at the receiver.

Improves system performance in the presence of random noise as opposed to burst noise, while requiring a marginal increase in the bandwidth of the channel.

# Digital Audio Compression

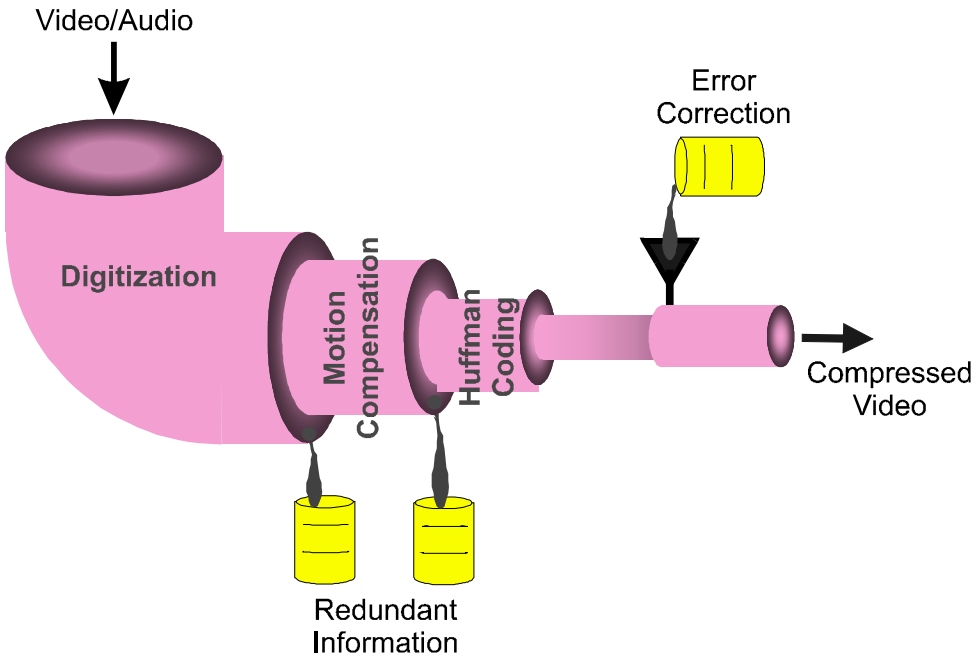



**Figure 8-10 Digital Compression Diagram**

# MPEG-2

## Overview

- MPEG-2, named after the Motion Picture Experts Group, is the proposed worldwide standard with support from more than 150 companies.
- Designed for compression of entertainment quality video signals for transmission and storage on various media.
- Umbrella specification defining rules to be followed.

## Video

- Many vendors of both encode and decode technology and products.
- Very flexible compression to meet many needs and qualities.
- MPEG-2 main profile mode uses bidirectionally-predicted frames.
- Full MPEG-2 requires 16 Mbytes of video decoder RAM.

## Transport

- Robust to errors.
- Low overhead (efficient).
- Relatively straightforward encoder and decoder implementation.
- Facilitates quick and reliable signal acquisition.
- ATM friendly. ATM (asynchronous transfer mode) is a method for carrying video, voice, and data signals on a network with specific switching standards. It is a gateway between telephone and video architectures.

# Digital Signal Processing

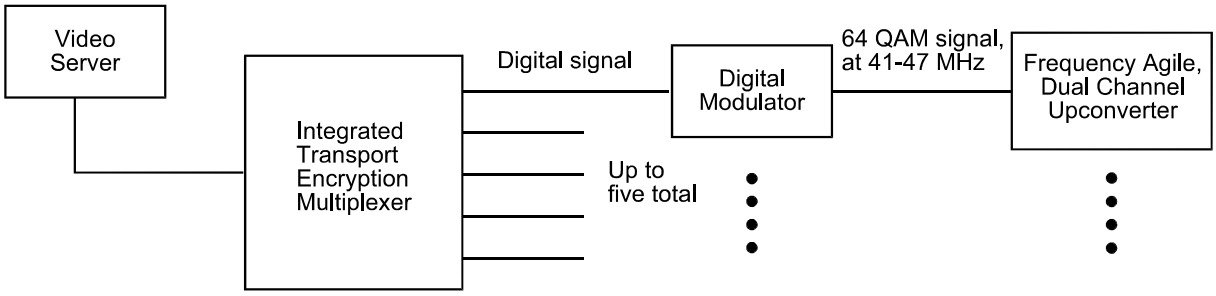


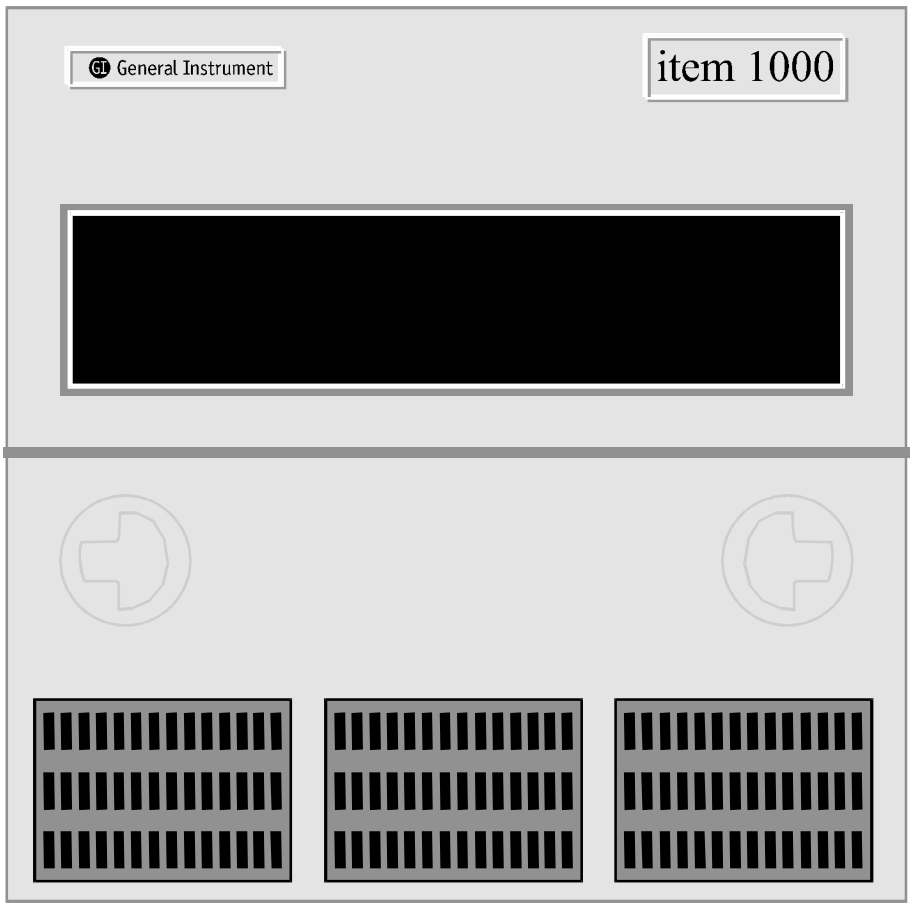

**Figure 8-11 Digital Signal Processing**

## Integrated Transport Encryption Multiplexer, ITEM 1000

Receives a single SONET (OC-3C @ 155Mbps) optical input data stream containing information from multiple providers.

Outputs up to five 27 Mbps connections for in-band transmission to a 64 QAM modulator (typically an IM 1000 In-band Modulator)

Outputs one 1.544 Mbps transport data stream for out-of-band transmission, for cable terminal control purposes.




Fi2gure 8-12 Integrated Transport Encryption Multiplexer (ITEM1000)

## Digital Modulator, IM 1000

Receives its input signal carrying a multiplex of digital services from the Integrated Transport Encryption Multiplexer.

Provides Forward Error Correction (FEC) encoding of the bitstream.

Converts the 27 Mbps data stream to a 64 QAM modulated RF signal in a 5 MHz IF bandwidth.

Outputs the in-band signal centered at 44 MHz IF for upconversion and cable transmission.

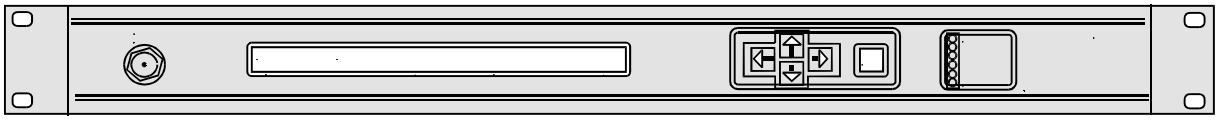


Figure 8-13 Digital Modulator (IM 1000)

### Frequency-Agile Dual-Channel Upconverter, C6U

Converts the 64 QAM IF signals from the Digital Modulator to any cable RF output channel. Can handle two channels in a compact rack unit and accepts inputs between 41 and 47 MHz.

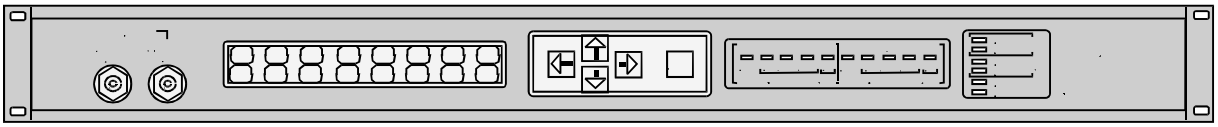


Figure 8-14 Dual Channel Upconverter

## Satellite Signal Processing

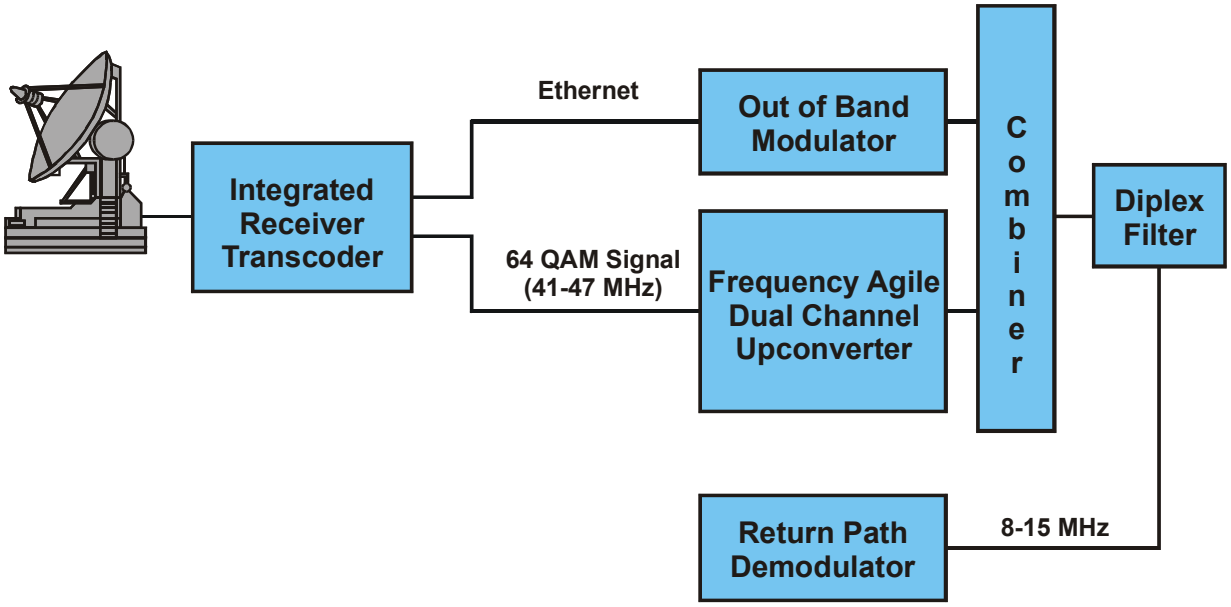



Figure 8-15 Satellite Signal Processing

## Integrated Receiver Transcoder, IRT 1000

Receives a QPSK-modulated L-band input from a satellite downconverter and produces a 64 QAM-modulated signal for cable transmission in a 6 MHz-wide television RF channel

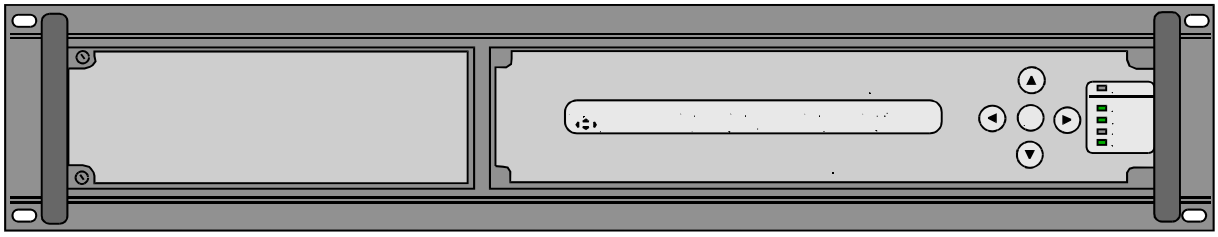


**Figure 8-16 Integrated Receiver Transcoder (IRT 1000)**

## Out-of-Band Modulator, OM 1000

- Creates a QPSK-modulated signal to carry the out-of-band (OOB) digital data stream from the headend to the subscriber's homes.
- The OOB data stream is the control link through which the headend transmits the commands and authorization messages that control the cable terminals.
- The headend can also use the OOB data stream to deliver other types of information like Electronic Program Guide (EPG).

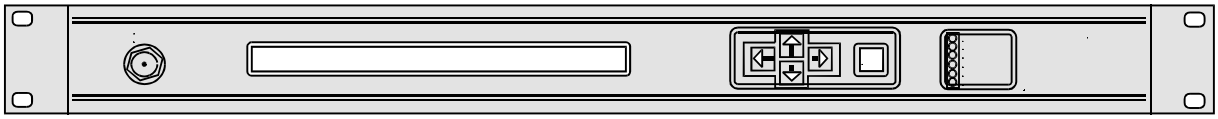


**Figure 8-17 Out of Band Modulator (OM 1000)**

### Return Path Demodulator, RPD 1000

- Receives, demodulates, and processes upstream data from the subscribers digital cable terminal.
- The received data bursts, from one to six channels, are demodulated and multiplexed into a single data packet which is transferred to a controlling processor via an Ethernet port.

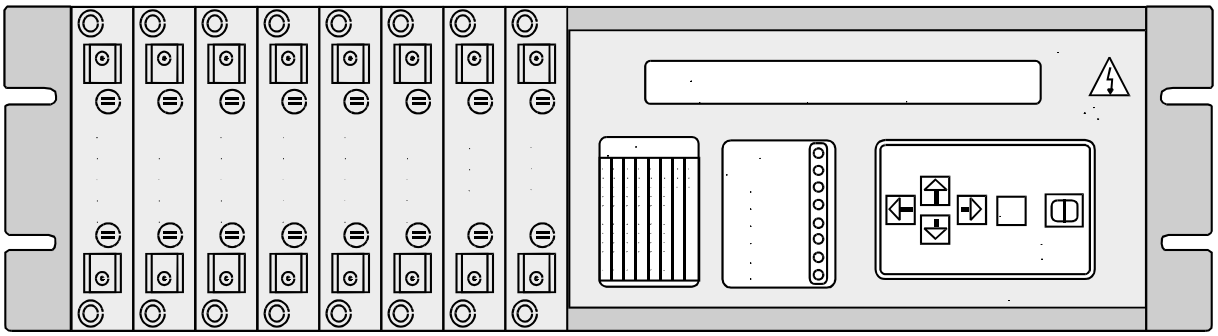


**Figure 8-18 Return Path Demodulator (RPD 1000)**

## Digital Video Delivery to the Home

### Quadrature Amplitude Modulation (QAM)

A form of double side band modulation. The data stream is split into two half-rate streams. One of the data streams modulates a sine wave carrier, the other a cosine carrier at the same frequency. The resultant signal looks like a vestigial side band signal with no pilot carrier present.

### Advantages of QAM

- QAM carriers can be carried by standard broadband networks, AM fiber optic, and coaxial distribution systems.
- QAM is the standard modulation for contemporary modems.
- QAM requires no pilot tone.
- QAM is the simplest digital modulation technology bit rate.
- QAM has a fast carrier acquisition and will appeal to “channel surfers.”

### Forward Error Correction

- Redundant bits are added to the data stream to allow the correction (replacement) of any information bits lost in transmission.
- Concatenated Trellis and Reed-Solomon error correction are used to correct practically all errors caused by fiber/coax transmission systems.
- FEC allows operation at a low broadband network carrier-to-noise (C/N) level of 25 dB.

### DCT1000

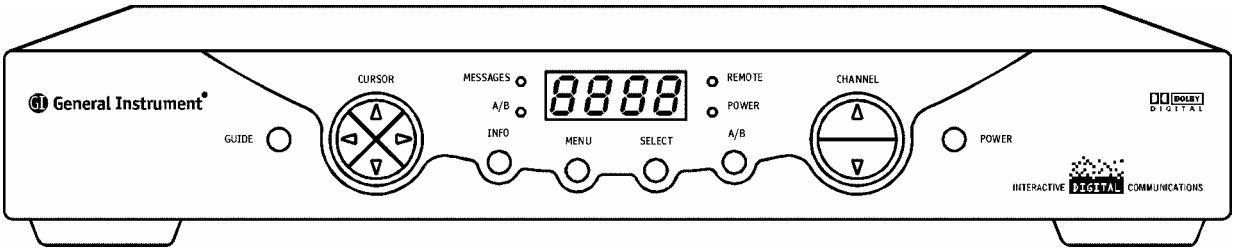



**Figure 8-19 DCT2000 Set-Top Terminal**

## Standards

- The transition from analog to digital in cable television drives the need for standards
- Standards permit interoperability
- Interoperability means interchangeable, exchangeable and consistent hardware for cable operators

### The Motorola Digital TV system

A System of Standards

- MPEG-2 Video
- ATSC/ABSOC Dolby® AC-3 Audio
- MPEG-2 Transport
- ATSC/ABSOC System Information (SI)
- ITU Trellis Coded QAM/FEC
- Submitting QPSK to ITU

Same as ATSC North American Broadcast System (except transmission).

## Major Digital Standards Efforts

| | MPEG-2 | ATSC/ABSOC | DCII | DVB | DAVIC | ITU | DSS |
|---|---|---|---|---|---|---|---|
| **Video** | MPEG-2 (various levels, profiles) | MPEG-2 (SD, HD) | MPEG-2 (SD) (NTSC, PAL) | MPEG-2 (SD) (PAL) | MPEG-2 | — | MPEG-2 (MP?) |
| **Audio** | Musicam (MPEG-1) | Dolby AC-3 | Dolby AC-3 | Musicam | Musicam | — | Musicam |
| **Data** | — | — | | — | — | — | — |
| **Transport** | MPEG-2 | MPEG-2 | MPEG-2 | MPEG-2 | MPEG-2/ATM | — | Proprietary |
| **System Info** | — | ATSC/ABSOC (with virtual channels) | ATSC/ABSOC (with virtual channels) | DVB (no virtual channels, no SCPC, no C band) | TBD | — | Proprietary |
| **Transmission** | — | VSB (UHF/VHF broadcast) | ITU Trellis QAM | ITU R-S QAM | ITU R-S QAM | N. America<br>1. ITU Trellis QAM<br>2. VSB<br>Europe<br>ITU R-S QAM | — |
| **AC&E** | — | — | DCII | Super scrambler encryption (Not A.C.) | TBD | — | News Datacom |

## Review

1 What are the decimal values indicated?

0 0 0 0 0 0 1 0 = _____

0 0 0 1 0 0 0 1 = _____

0 1 0 0 1 0 0 0 = _____

1 0 0 0 0 0 1 0 = _____

0 0 1 1 1 1 0 0 = _____

0 1 0 1 0 1 0 1 = _____

4 Name three near future services. _____

_____

_____

_____

5 List two advantages of digital service. _____

_____

6 The minimum sampling rate equal to twice the highest frequency to be sampled is referred to as _____

7 Assigning discrete digital values to a sampling of an analog signal is referred to as _____

8 What is the practical sampling rate for digitizing a DS0? _____

9 What is DSP? _____

10 What transmission standard will be used for digital video in the home? _____

11 What does the acronym MPEG stand for? _____

12 When digitized, a non-compressed, analog video signal can be transported at a rate of _____Mbps

Section 9

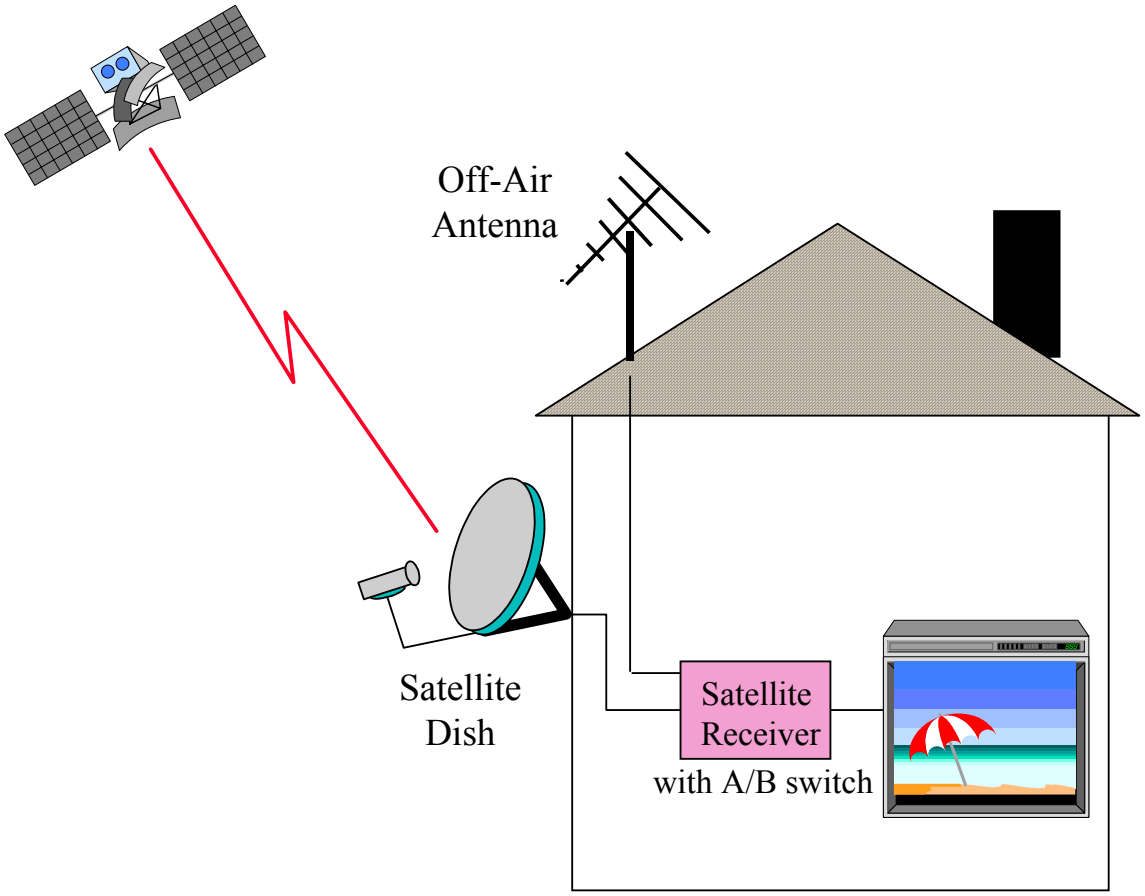
# Alternative Digital Technologies

After completing this section of the course, you will have an understanding of alternate digital technologies, such as direct broadcast Satellite and wireless cable.

## Direct Broadcast Satellite

Direct Broadcast Satellite (DBS) service providers, such as Direct TV, broadcast to subscriber's homes directly from a satellite. Subscriber's who wish to receive local channels need an antenna and some means to switch between the satellite and local broadcast signals. Internet services are available with DBS.

The return path for PPV purchases, Internet connection, and the like is by way of the telephone.




## Wireless Systems

Three types of wireless cable delivery systems:

- Multichannel Multipoint Distribution Service (MMDS)
- Local Multipoint Distribution Service (LMDS)
- Satellite Master Antenna Television (SMATV)

## Multichannel Multipoint Distribution System (MMDS)

MMDS is a cable TV delivery system that rebroadcasts signals directly to subscribers.

- Frequency range: 2.5 to 2.7 GHz.
- Transmit radius up to 30 miles.
- 33 analog channels available.
- 20 channels allocated to ITFS.
- Up to 14 digital services (programs/channels), depending on the compression ratio.
- Limited to *line-of-sight*.
- 4 MHz response channel - used for distance learning and educational programming.
- Telephone (Telco) return path.

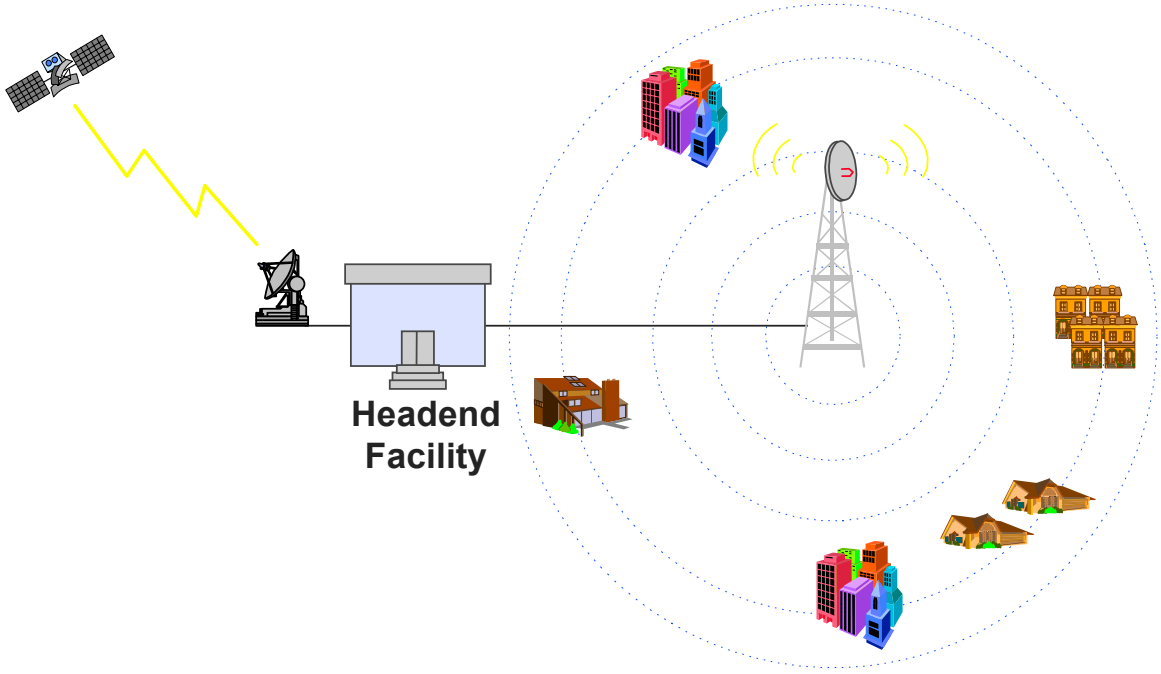



**Figure 9-1 Wireless - MMDS System**

## Local Multipoint Distribution System (LMDS)

LMDS systems transport the headend signals over fiber to cell nodes that transmit over-the-air to subscribers.

- Fiber-interconnect to cell nodes.
- Frequency range: 27.5 to 29.25 GHz.
- Cell radius 3 to 6 miles.
- 41 analog channels.
- Up to 14 programs/channel with digital transmission.
- Limited to *line-of-sight* transmission.

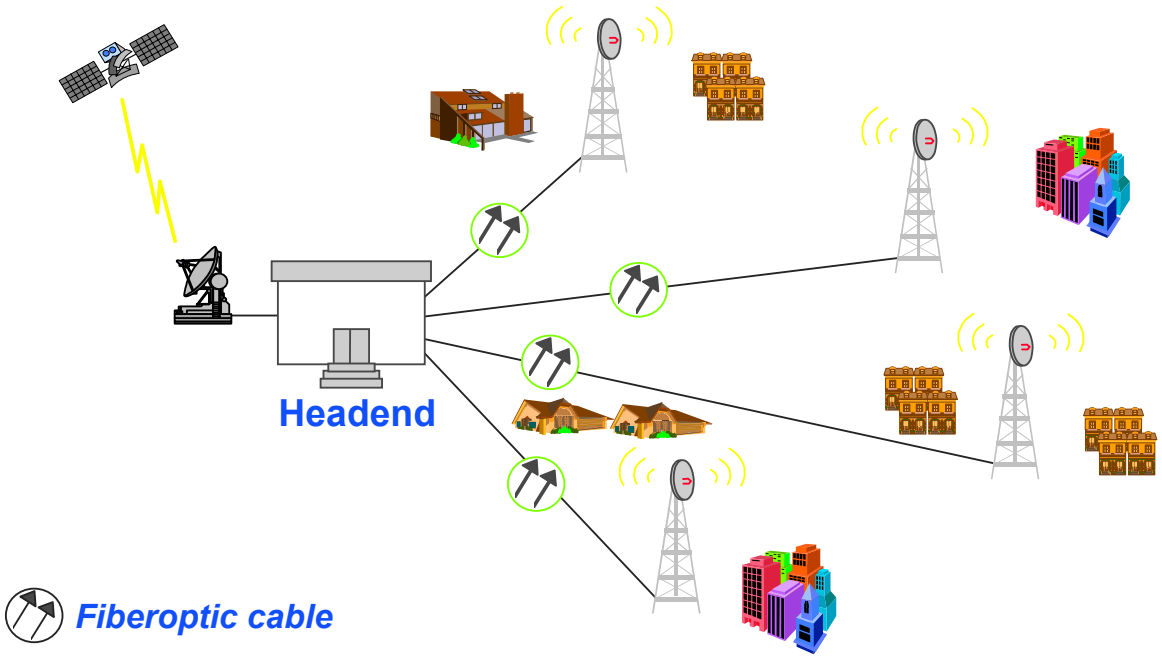



**Figure 9-2 Wireless - LMDS System**

## Satellite Master Antenna System (SMATV)

SMATV systems serve residential, multi-dwelling units (MDUs), such as hotels.

- Unfranchised, stand-alone system.
- MDUs are linked via microwave facilities.
- 18 GHz.

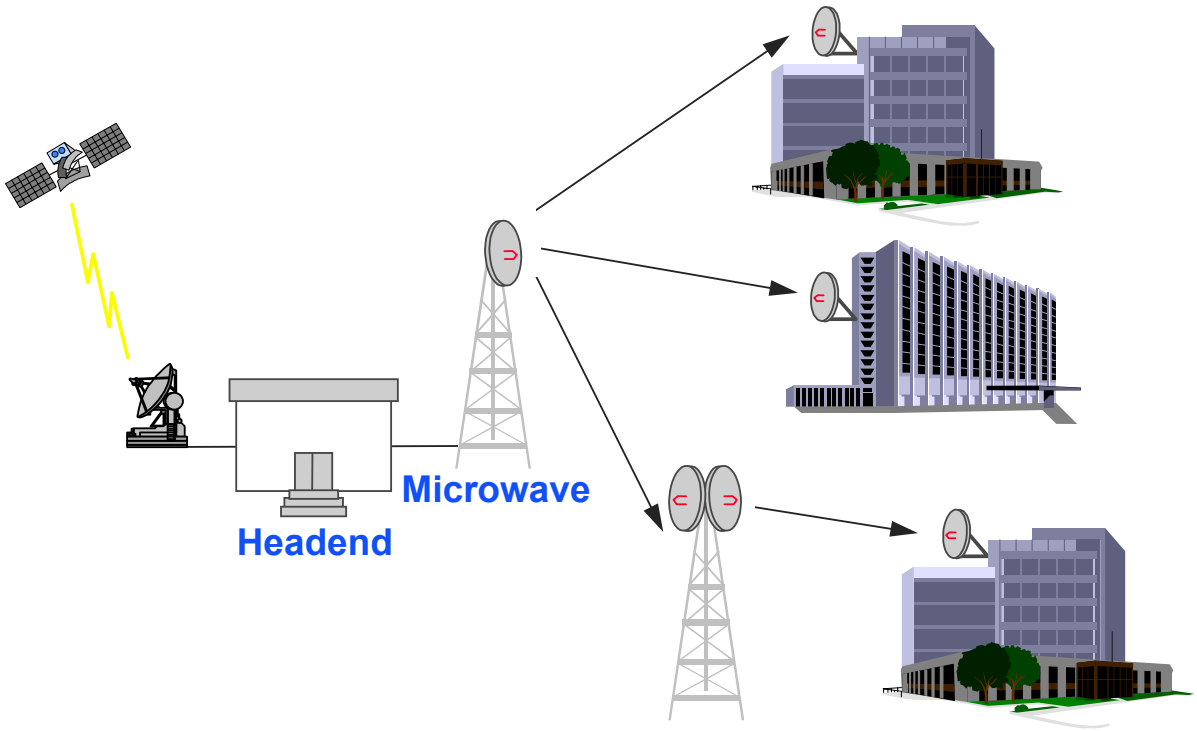



**Figure 9-3 SMATV Delivery System**

# Glossary

## Acronym List

| | |
|---|---|
| AAL5-CP | ATM Adaptation Layer 5-Common Part |
| AC | Access Controller |
| ac | Alternating Current |
| AC-3 | Audio Compression-3 |
| ACC 4000 | Addressable Controller Computer |
| ACC 4000D | Addressable Controller Computer (Digital) |
| ACP | Access Control Processor |
| ACSM | Automatic Channel Scheduling and Maintenance (GI Department) |
| A/D | Analog to Digital (Converter) |
| ADM 1000G | Add/Drop Multiplexer 1000 Groomer |
| ADSL | Analog Digital Signal Line |
| ADM 1000 | Add/Drop Multiplexer 1000 |
| AGC | Automatic Gain Control |
| AM | Amplitude Modulation |
| AML | Amplitude Modulating Link |
| ANI | Automatic Number Identification |
| ANIC | Addressable Network Interface Card |
| ANIC-A | Addressable Network Interface Controller-A |
| ANSI | American National Standards Institute |
| APC | Angle Physical Contact connector |
| ARU | Automated Response Unit |
| ASCII | American Standard Code for Information Interchange |
| ASEM | Access Subnetwork Element Manager |
| ASG | Automated Seed Generator |
| ASI | Asynchronous Serial Interface |
| ATM | Asynchronous Transfer Mode |
| ATP | Acceptance Test Plan |
| BB | Baseband |
| BER | Bit Error Rate |
| B-ISDN | Broadband Integrated Services Digital Network |
| BNC | British Naval Connector |
| bootp | Bootstrap protocol (UNIX) |
| bps | bits per second |

| | |
|---|---|
| BPSK | Bipolar-Phase Shift-Key – modulation scheme |
| BSG | Billing/Business System Gateway |
| BSI | Billing System Interface |
| BSITL | Business System Interface Transaction Logger |
| BTSC | Broadcast Television Systems Committee |
| BW | Bandwidth, in Hz |
| C/N | Carrier-to-noise ratio |
| C6M | Commander 6 Modulator |
| C6/8U | Commander 6/8 Upconverter |
| CAT | Conditional Access Table |
| CATV | Cable Access Television |
| CBI | Character Based Interface |
| CBIS | Cincinnati Billing Information Systems |
| CCITT | Consultative Committee for International - Telegraph and Telephone |
| CDC | Control Data Channel |
| CDMA | Code Division Multiple Access |
| CFL | Customer Features List |
| CFT2200 | Consumer Friendly Terminal 2200 |
| CHEE | Cable Headend Encryption Engine |
| CIE | Commission Internationale de l'Eclairage (Commission on Illumination) |
| CLR | Cable Loss Ratio |
| C/N | Carrier-to-Noise |
| CPU | Central Processing Unit |
| CRC | Cyclic Redundancy Check |
| CRT | Cathode Ray Tube |
| CSG | Cable Services Group |
| CSMA/CD | Carrier-Sense Multiple Access with Collision Detection |
| CSO | Composite Second Order beat |
| CTB | Composite Triple Beat |
| CTL | Cable Television Laboratories |
| CVS | Cable Video Store |
| CW | Continuous Wave |
| DA | Distribution Amplifier (Video) |
| D/A | Digital to Analog (Converter) |
| DAC 6000 | Digital Addressable Controller 6000 |
| DANIS | Digital Access Network Interface Subsystem |
| dB | Decibel |
| dBc | Signal level expressed in dB relative to the unmodulated desired carrier level |
| dBi | Measures gain in decibels above an isotropic radiator (antenna) |
| dBm | Decibel referenced to 1 mW |
| dBmV | Signal level expressed in dB relative to 1 mV across a impedance of 75 ohms |
| DBS | Direct Broadcast Satellite |

| | |
|---|---|
| dc | Data Collector |
| DC | Direct Current |
| DCA-CR(FR) | Data Commander - Frame |
| DCA-DF | Data Commander - FM-Band Demodulator |
| DCA-DS | Data Commander - Sub-Band Demodulator |
| DCA-MF | Data Commander - FM-Band Modulator |
| DCA-MS | Data Commander - Sub-Band Modulator |
| DCA-PC | Data Commander - Power Controller |
| DCA-SE | Data Commander - Squelch Eliminator |
| DCR | Digital Cable Radio |
| DCSI | Data Collector System Interface |
| DCT 1000 | Digital Consumer Terminal 1000 |
| DCT 2000 | Digital Consumer Terminal 2000 |
| DCT 5000 | Digital Consumer Terminal 5000 |
| DCT | Discrete Cosine Transform |
| DES | Data Encryption Standard |
| DES | DigiCipher II Encoded Signals |
| DFB | Distributed Feedback Laser |
| DGI | Data Generator Interface |
| DHEI | Digital Headend Equipment Interface |
| DIU/M | Data Insertion Unit/Module |
| DLS | DownLoad Server |
| DNS | Domain Name Server |
| DPM | Data Path Modulator |
| DPT | Data Provider Translator |
| DRAM | Dynamic Random Access Memory |
| DS/E | Digital Scrambler Encoder |
| DS-16 | Data Splitter-16 |
| DSR-4400 | Digital Satellite Receiver-4400 |
| DSR-4500 | Digital Satellite Receiver-4500 |
| DSP | Digital Signal Processor |
| DSS | Digital Satellite System |
| DTS | Decoding Time-Stamp |
| DVB | Digital Video Broadcast |
| DVS | Digital Video System |
| DVT | Design Verification Test |
| DWT | Digital Wireless Terminal |
| EAS | Emergency Alert System |
| EBS | Emergency Broadcast System |
| ECC | Encryption Control Center |
| ECM | Entitlement Control Message |
| EEB | Entitlement Engine Board |

| | |
|---|---|
| EECS | Encryption Engine Board |
| EEE | Encryption Engine Element |
| EEPROM | Electrically Erasable Programmable Read-Only Memory (chip) |
| EES | Encryption Engine System |
| EIA | Electronics Industry Association |
| ELBB | End-of-line Big Burst |
| EMM | Entitlement Management Message |
| EMS | Encoder Management System |
| EPG | Electronic Program Guide |
| EPPV | Enhanced Pay-Per-View |
| EPROM | Erasable Programmable Read-Only Memory |
| EROM | Erasable Read-Only Memory |
| ES&F | Enhanced Store and Forward |
| ESA | Earth Station Antenna |
| ESD | Electrostatic Discharge |
| FCC | Federal Communications Commission |
| FDMA | Frequency Division Multiple Access |
| FEC | Forward Error Correction |
| FEM | Feature Expansion Module |
| FIFO | First-In-First-Out buffer |
| FIR | Finite Impulse Response |
| FM | Frequency Modulation |
| FSI | File Server Interface |
| FSIC | File Server Interface Controller |
| FSK | Frequency Shift Key |
| FTP | File Transfer Protocol |
| FTTC | Fiber-to-the-Curb |
| FTTN | Fiber-to-the-Node |
| GCR | Group Configuration Request |
| GHz | Gigahertz |
| GMT | Greenwich Mean Time |
| GMT/UDT | Greenwich Mean Time/Universal Date and Time |
| GPS | Global Positioning System |
| GUI | Graphical User Interface |
| HCT 1000 | Headend Configuration Tool 1000 |
| HDTV | High Definition Television |
| HFC | Hybrid Fiber Coax |
| HFW | Hybrid Fiber /Wireless |
| HITS | Headend In The Sky |
| HMS | Headend Management System |
| HPA | High Power Amplifier |
| HRC | Harmonically-Related Carriers |

| | |
|---|---|
| HSCI | High Speed Cable Interface |
| HSI | High Speed Interface |
| HSSIO | High Speed Serial I/O |
| HSTM | High Speed Transport Multiplex |
| HTML | HyperText Markup Language |
| HTTP | HyperText Transfer Protocol |
| Hz | Hertz |
| IBB | In-Band Barker |
| IC | Integrated Circuit |
| ICC | Incremental Coherent Carriers |
| IEEE | Institute of Electrical and Electronic Engineers |
| IF | Intermediate Frequency |
| IM 1000 | In-band Modulator 1000 |
| IMTV | Interactive Media Television signals |
| INTS | Interoperable Network Technology System |
| IP | Internet Protocol |
| IPG | Interactive Program Guide |
| IPGT | Interactive Program Guide Translator |
| IPPV | Impulse Pay-Per-View |
| IR | Infrared |
| IRC | Incrementally-Related Carriers |
| IRD | Integrated Receiver Decoder |
| IRE | Insitute of Radio Engineers |
| IRT 1000/2000 | Integrated Receiver Transcoder 1000/2000 |
| ISDN | Integrated Services Digital Network |
| ISI | Inter-Symbol Interference |
| ISP | Internet Service Provider |
| ISV | Independent Software Vendor |
| ITEM 1000 | Integrated Transport Encryption Multiplexer 1000 |
| Kbps | Kilobits per second |
| kHz | Kilohertz |
| KLS 1000 | KeyList Server 1000 |
| LAN | Local Area Network |
| LASER | Light Amplification by Stimulated Emission of Radiation |
| LED | Light Emitting Diode |
| LNA | Low Noise Amplifier |
| LNB | Low Noise Block Downconverter |
| MAC | Media Access Control |
| MAM | Multiple Application Manager |
| Mb | Megabit |
| Mbps | Megabits per second |
| MB | Megabyte |

| | |
|---|---|
| MCNS | Multimedia Cable Network System |
| MCPC | Multiple Channels Per Carrier |
| ME 1000 | Message Editor 1000 |
| MHz | Megahertz |
| MIPS | Millions of Instruction Per Second |
| MMDS | Multi-channel Multi-point Distribution Service |
| MPAA | Motion Picture Advisory Association |
| MPEG | Moving Picture Experts Group |
| MPEG-2 | Moving Picture Experts Group, rev. 2 of standard |
| MPS | Modular Processing System |
| ms | milliseconds |
| MSO | Multiple System Operator |
| MUX | Multiplexer |
| MVP | Modulating Video Processor |
| NC 1500 | Network Controller 1500 |
| N/C | No Connection (i.e. open circuit) |
| NCS | Network Control System |
| NCTA | National Cable Television Association |
| NDIS | Network Driver Interface Specification |
| NDP | Network Data Processor, NDP 1000 |
| NESC | National Electric Safety Code |
| NFPA | National Fire Protection Association |
| NRZ | Non-Return to Zero |
| NTD | Network Termination Device |
| NTP | Network Time Protocol |
| NTS | Network Time Server |
| NTSC | National Television Systems Committee |
| NVMEM | Non-Volatile Memory |
| NVOD | Near Video On-Demand |
| NVRAM | Non-Volatile Random Access Memory |
| OAM | Operations and Maintenance |
| OAM&P | Operations, Administration, Maintenance, and Provisioning |
| OBB | Out-of-Band Barker |
| OBTM | Out-of-Band Transport Multiplex |
| OC | Optical Carrier (SONET) |
| OLL | Off Line Loader |
| OM 1000 | Out-of-band QPSK Multiplexer/Modulator 1000 |
| OOB | Out-of-Band |
| OQPSK | Offset Quadrature Phase ShitKey |
| OSD | On-Screen Display |
| OSI | Open Systems Interconnection |
| OSS | Operational Support Systems |

| | |
|---|---|
| OTN | Optical Transition Node |
| PAL | Phase Alternation by Line |
| PAT | Program Association Table |
| PCR | Program Clock Reference |
| PDF | Program Development Facility |
| PDU | Protocol Data Unit |
| PEG | Public/Educational/Government |
| PES | Packetized Elementary Stream |
| PID | Packet IDentifier (MPEG-2 value) |
| PING | Packet INternet Grouper |
| PLL | Phase-Lock Loop |
| PMT | Program Map Table |
| POTS | Plain Old Telephone Service |
| PPP | Point-to-Point Protocol |
| PPV | Pay-Per-View |
| PROM | Programmable Read-Only memory |
| PROS | Permissions, Resource, Object Signatory |
| PSI | Program Specific Information |
| PSK | Phase Shift Key |
| PSL | Pay Service Loader |
| PTS | Presentation Time-Stamp |
| QAM | Quadrature Amplitude Modulation |
| QIC | Quarter-Inch Cartridge |
| QPSK | Quadrature (4-level) Phase ShiftKey |
| QR | Quantum Reach |
| QVP | Quad Video Processor |
| RAID | Redundant Array of Independent Disks |
| RAM | Random Access Memory |
| RF | Radio Frequency |
| RFI | Radio Frequency Interference |
| RMS | Root Mean Square |
| ROM | Read-Only Memory |
| RPC | Remote Procedure Call |
| RPD 1000 | Return Path Demodulator 1000 |
| RPD 2000 | Return Path Demodulator 2000 |
| S/N | Signal-to-Noise |
| SA | Scientific-Atlanta |
| SABRE | SONET/ATM BiCMOS Receiver/Transmitter |
| SAC | Subscriber Authorization Center |
| SAR | Segmentation And Re-assembly processor |
| SAW | Surface Acoustic Wave |
| SBM | Simulated Bit-mapped Mode |

| | |
|---|---|
| SC | Service Controller (Level-One Gateway) |
| SCC | Service Control Channel |
| SCPC | Single Channel Per Carrier |
| SCSI | Small Computer System Interface (pronounced “skuzzy”) |
| SCTE | Society of Cable & Telecommunication Engineers |
| SDC | Service Data Channel |
| SDU | Service Data Unit |
| SECAM | Sequential Couleur Avec Memorie (sequential color with memory) |
| SM | Service Multiplexer, ITEM 1000 kernel processor |
| SMPTE | Society of Motion Picture and Television Engineers |
| SMS | Subscriber Management System |
| SNMP | Simple Network Management Protocol |
| SONET | Synchronous Optical Network |
| SPDIF | Sony-Phillips Digital Interface |
| SPI | Synchronous Parallel Interface |
| SQL | Structured Query Language |
| SSTM | Single Service Transport Multiplex |
| STS | Synchronous Transport Signal |
| STU | Set Top Unit |
| SVRAM | Synchronous Video Random Access Memory |
| SVT II | Starvue II Terminal |
| TAC | Total Addressable Control |
| TAXI | Transparent Asynchronous Xmit/Receive Interface |
| TCP | Time Controlled Programming |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| TDC | Transdata Combiner 16 |
| TDMA | Time Division Multiple Access |
| TFTP | Trivial File Transport Protocol |
| TLE | Transmission Line Equalizer |
| TM | Transport Multiplexer kernel processor ITEM 1000 |
| TNA | Telephone Network Adapter |
| TS | Transport Stream |
| TSODA | Transport Sync OSD DES Audio |
| TTY | Teletype |
| TVRO | Television Receive Only |
| UCS | Uplink Control System |
| UDM | User Data Message |
| UDP | User Datagram Protocol |
| UDT | Universal Date and Time |
| UHF | Ultra High Frequency |
| UIS | User Interface Subsystem |
| UKL | Unit Key List |

| | |
|---|---|
| UMS | Uplink Management System |
| UPM | User Processor Module |
| UPS | Uninterruptible Power Supply |
| URC | Universal Remote Control |
| URC-IPG | Universal Remote Control - Interactive Program Guide |
| URL | Uniform Resource Locator |
| UTC | Universel Temps Coordonne (universal coordinated time) |
| UTP | Unshielded Twisted Pair |
| VBI | Vertical Blanking Interval |
| VCAS | Virtual Channel Authoring System |
| VCI | Virtual Channel Indicator |
| VCM | Virtual Channel Map |
| VCN | Virtual Channel Number |
| VDT | Video Dial Tone |
| VHF | Very High Frequency |
| VLSI | Very Large Scale Integrated (Circuit) |
| VOD | Video On-Demand |
| VOP | Velocity of Propagation |
| VPI | Virtual Path Indicator |
| VRAM | Video Random Access Memory |
| VRAM | Volatile Random Access Memory |
| VSB | Vestigial Side-Band |
| 8–VSB | 8 level Vestigial Side Band |
| WWW | World Wide Web |
| XM | Cross Modulation |

# Definitions of Terms

**802.2**

Standards for the logical link control sublayer of the data link layer.

**802.3**

CSMA/CD (Ethernet) standards, which apply at the physical layer and the media access control (MAC) sublayer.

**10 Base T**

The IEEE standard for twisted pair Ethernet. It uses telephone wiring and standard RJ-45 connectors. It is wired in a star configuration and requires a hub.

**100 Base T**

The group of proposed IEEE 802.3 physical layer specifications for 100 Mbps Ethernet (Fast Ethernet) over various wiring specifications.

**AAL5-CP**

ATM Adaptation Layer 5–Common Part. A protocol used to segment and reassemble digital data streams for ATM transport.

**AC**

(Alternating Current) An electrical current where the polarity is periodically reversed.

**ACC-4000D**

Addressable Control Computer 4000 Digital, previous version of the DAC 6000.

**Access Control**

All functions required for encrypting the digital signals and providing them to subscribers individually or in groups. It includes tagging individual program services, virtual channel mapping, all other features which are not video and audio program or low speed data related, text services and program guides. Access requirements are specified for each program in a service by the ECM stream and if a unit possesses access rights that match access requirements, will allow the unit to access the program. Access requirements may change on a program by program basis. Access Rights (entitlements) are delivered to each individual unit by the EMM stream and determine the units service access capabilities, for example, defined tiers will determine any individual units ability to receive a service. Access rights are generally delivered to a unit and will remain in effect for some period of time. Immediate changes to access rights are also possible.

**access control data**

A stream of 8-bit characters sent by the access controller to manipulate various devices in an addressable system. It contains global, group, and specifically addressed commands to controlled devices, such as set-top terminals.

**access control element (ACE)**

Element that provides the system security handling on the DCT 1000. See TSODA for more information.

**access requirements**

Access requirements are specified for each program in a service by the ECM stream and if a unit possesses access rights that match access requirements, will allow the unit to access the program. Access requirements may change on a program by program basis.

**access rights**

Access rights (entitlements) are delivered to teach individual unit by the EMM stream and determine the units service access capabilities, e.g., defined tiers will determine any individual units ability to receive a service. Access rights are generally delivered to a unit and will remain in effect for some period of time. Immediate changes to access rights are also possible.

**Access Subnetwork Element Manager (ASEM 1000)**

A General Instrument Inc. software component (ASEM 1000) of the digital headend system that instructs the ITEM 1000 to provide downstream in-band network services. It also coordinates the delivery of ECM messages from the DAC 6000 to the ITEM 1000.

**ad Inserts**

A commercial break within a network schedule that can be sold locally. An audio signal (or the equivalent) cues the local affiliate to cover the break and air the local spot.

**adaptive equalization**

A function of the DCT 1000 that minimizes the effects of micro reflections found in cable plants and in-home wiring.

**Add/Drop Multiplexer (ADM 1000)**

Equipment that provides the ability to groom more than one MPEG transport stream at the headend. This allows for the injection of local digital signals or substitution of programming as received from any given transponder.

**address**

A unique identifier, generally a number, assigned to a device within a system.

**addressability**

The capability of controlling operations of remote devices by sending a command from a central computer.

**addressable**

The ability to control Subscriber Services from the Headend via a uniquely addressed Device.

**addressable controller**

An access control computer used to control addressable set-top terminals.

**adjacent channel interference**

Interference in a given channel, caused by the operation of an adjacent channel.

**AFP**

AppleTalk Filing Protocol - Protocol that lets workstations access files from remote file servers. The protocol corresponds to layer 6 of the OSI Reference Model.

**AGC**

(Automatic Gain Control) The process of maintaining a pre-determined signal level output by monitoring a specific frequency over a range of temperatures.

**Alamar**

A broadcast automation system used at NDTC that controls playback of logged elements from Master Control.

**alignment**

The process of tuning or adjusting (either manually or electronically) equipment such as an earth station antenna and receiver, to maximize sensitivity and signal reception capabilities.

**AM/FM/PM Modulation**

The process of changing a waveform by varying the amplitude, frequency or phase to transmit information. - Amplitude Modulation/Frequency Modulation.

**Amplifier**

Device used to increase the operating level of an input signal.

**Amplifier Interstage Tilt**

A predetermined difference between the high and low channel provided by a plug-in electronic card.

**Amplifier Tilt**

The output signal level difference between the high and low channels. The high channel is always greater in signal level.

**amplitude**

The vertical distance between two points of a waveform or signal expressed in voltage. The size or magnitude of a voltage or current wave form; the strength of a signal.

**amplitude modulating link (AML)**

A terrestrial microwave link using amplitude modulation.

**amplitude modulation (AM)**

A method of modulation in which the amplitude (or power) is varied and the frequency remains constant. Used in the luminance portion of the television signal.

**analog channel**

A frequency band 6 MHz wide allocated within a cable frequency bandwidth that carries an analog television signal. Each Analog Channel carries one video and one associated audio signal at a time. (See also Digital Channel.)

**antenna**

Any structure or device used to collect or radiate electromagnetic waves.

**antenna array**

An antenna comprised of a number of identical radiation elements in a regular arrangement and excited to obtain a prescribed radiation pattern.

**Antitaping**

The process of altering the video signal such that normal (or unmodified) VCRs cannot record the signal with high entertainment quality.

**ATM**

Asynchronous Transfer Mode - An international packet switching standard established by CCITT, in which the network routing instructions and control information are part of the message itself. ATM will operate at speeds of 2 Gbps and features the transmission of uniform cells of 53 bytes length each. Of that total, 48 bytes represent the payload while 5 bytes represent the header. The header portion of the message unit identifies the owner of the transmitted information. ATM headers also identify the circuit number to which the message is sent. The header also contains error control information. Because each of the cells (which may be thought of as "packets") is of identical length, whether completely full of data or empty, they can be switched quickly through a network. In part, that advantage arises because the work doesn't have to spend time examining each packet to read its address information and assess the length of the packet. Cell relay systems, such as ATM, are desirable when transmitting vide

**ATM connection**

An association established at the ATM layer to support communication between to end-to-end entities. Generally, the connection can be either a virtual channel connection or a virtual circuit connection. The ITEM 1000 currently supports only virtual channel connections.

**ATM Router**

Delivery of digital signal by ATM.

**attenuation**

Difference between power transmitted and power received because of loss through transmission mediums. Expressed in decibels.

**audio loop-thru**

An audio connection that would allow the audio signal to be passed through a particular piece of equipment.

**Augmented Message Stream (AMS)**

A message stream that has been divided for insertion into transport packet payloads, and include a single pointer byte in the first position of each payload only when that payload contains the start of one or more messages, and optional padding bytes. An augmented message stream is converted into transport packets labeled with a single PID through the addition of transport packet headers and transport adaptation fields.

**Authorization Station (AS)**

The AS allows users to authorize/de-authorize/trip certain services within an Integrated Receiver Decoder (IRD) or the entire IRD itself. Currently, this is designed only for IRDs with the intention for it to be enhanced for Integrated Receiver Transcoders (IRTs).

**Automated Call Distribution (ACD)**

An automated system that answers phone calls and directs them to the appropriate Areas.

**Automatic Number Identification (ANI)**

ANI makes use of a phone system feature, which provides the phone number of the party calling. The phone number is used to identify a Subscriber. The ANI takes the order. This is another type of order source in addition to the Business Systems.

**Automated Response Unit (ARU)**

A person-to-machine mechanism for responding to incoming customer calls, where information is taken by reading touch-tone signals originating by telephone. An ARU can be programmed to provide answers to the most common interface inquiries and/or to route calls to the appropriate department, and can accept information such as account numbers or similar identification. Frequently used for PPV ordering.

**back end**

The system(s) that are responsible for the routing of set-top terminal dependent communications and managing the relationship to other devices responsible for delivering the message. This term is used in reference to the current TAC system only.

**backward compatible**

Also referred to as “downward compatible,” describing a new product that can be used with equipment or media originally designed for use with an older product.

**Bandwidth**

Range of useable frequencies, measured in Hz, transmitted over a communications line or channel.

**barker channel**

1. A Channel dedicated full-time to advertising other Channels or Services. 2. Override for an unauthorized selection of a Channel or Service. This override is used to indicate the unauthorized status of the Channel, or Service, or the promotion of other Services.

**base map**

A map containing streets, roads and landmarks. Base maps do not contain strand routing or design.

**base mode**

Mode that an Encoder should be in, if there is not an Event. Usually this is a Static Service.

**baseband**

Transmission scheme in which the entire bandwidth, or data-carrying capacity, of a medium (such as coaxial cable) is used to carry a single digital pulse, or signal, between multiple users. Because digital signals are not modulated, only one kind of data can be transmitted at a time. Contrast with broadband.

**baseband channel**

Connotes that modulation is used in the structure of the channel, as in a carrier system. The usual consequence is phase or frequency offset. The simplest example is a pair of wires that transmits direct current and has no impairments such as phase offset or frequency offset that would destroy wave form.

**baseband scrambling**

A scrambling technology effect by inversion of the video element of the signal. Baseband scrambling is generally more secure than RF Scrambling.

**beat**

A general term used to describe any high-frequency pattern in a television picture.

**Bi-directional**

Two-way cable communications (NCTA definition).

**Billing System Interface**

An interface between the billing and access control system that enables automatic billing of authorized services.

**Binary Numeration System**

A system of numeration, based on 2, in which the numerals are represented as sums of powers of 2 and in which all numerals can be written using the symbols 0 and 1.

**B-ISDN**

Broadband ISDN is a high-bandwidth version of ISDN intended to support applications such as full-motion video and image. It uses a basic signaling rate of 150 Mbps and is expected to support additional bandwidth in increments of about 50 Mbps, up to about 600 Mbps. (CED 4/94)

**Bit Error Rate (BER)**

Percentage of bits in a transmittal received in error.

**bit rate**

The speed, at which bits are transmitted, usually expressed as bits per second (bps).

**blanking interval**

The time during which the electron gun is turned off while scanning from one line to the next.

**bootstrap protocol (bootp)**

The communication protocol used to transfer initialization information between digital headend network elements and a central server. At power up, network elements issue a Bootp request. The Bootp server receives the request and responds with a Bootp reply that specifies startup information and operating parameters for the requesting device.

**broadband**

Wide bandwidth equipment or systems that can carry a relatively large proportion of the electromagnetic spectrum. A broadband communications system can accommodate broadcast as well as other services. Service requires 50-600 Mbps transport capacity.

**broadband communication**

Term characterizing both digital and analog transmission systems. If used to describe digital systems, transmission speed is given in bits per second (bps). If used to describe analog systems, transmission bandwidth is given in cycles per second (Hertz, abbreviated Hz). Broadband communication is generally understood to indicate either a fast data rate digital system or a wide bandwidth analog system.

**broadband communication systems**

Systems, digital and analog, that employs broadband communication. Examples of digital broadband communication systems include DS-3 systems with rates of 44.736 megabits per second (Mbps) and fiber digital distributed interface (FDDI) systems with rates of 100 Mbps. Examples of analog broadband communication systems include a broadcast television station with a 6 MHz bandwidth channel or an entire cable television system with a bandwidth of 550, 750 or even 1,000 MHz.

**broadcast automation**

The automated process that downloads a file from traffic and builds a schedule of breaks, spots promos to control the playback of logged elements automatically in Master Control.

**broadcast service providers**

The entity providing PPV schedules. May be superseded by MPS.

**BTSC**

The defacto multichannel television sound standard adopted by the Broadcast Television Systems Committee for stereo audio television broadcast.

**burst**

1. In data communication, a sequence of signals counted as one unit in accordance with some specific criteria or measure. 2. A color burst.

**Business System Interface (BSI)**

The interface between a Customer's computer system and the Authorization Center for the purpose of providing access and control of video programming Devices.

**busy time**

For Headend and set-top equipment processing time during which later transactions are ignored.

**byte**

A group of bits treated as a unit used to represent a character in some coding systems. A byte typically consists of eight bits and represents an amount of information roughly equivalent to a single printed or typewritten character. In special purpose data storage or memories, a byte may consist of more or fewer than eight bits.

**Cable Headend Encryption Engine (CHEE)**

Part of KeyList Server (KLS) that does actual encryption of digital programming signals. For local control only.

**cable loss**

An electrical characteristic of coaxial cable that causes signal level reductions. The signal level is reduced or attenuated because of distance and because of the signal's frequency. The longer the cable, or the higher the frequency, the greater the loss. Excessive cable loss will cause a customer's television reception to degrade

**Cable Loss Ratio (CLR)**

Ratio of cable attenuation at two frequencies is approximately equal to the square root of the ratio of the two frequencies.

**cable splice**

A mechanical or electrical connection to join two cables together.

**Cable Television Laboratories (CTL)**

A cable television research and development consortium founded in 1988 and located in Louisville, CO. Projects include cable test s of high definition television (HDTV), development of advanced cable architecture, and improvements in field testing and cable operations technology. Commonly referred to as Cablelabs.

**Cable Tilt of Slope**

The difference in gain between the lowest and the highest frequencies in a CATV system.

**carriage rules**

The set of contractual agreements and/or restrictions that determines which Services are carried over which Channels from what Headends and when.

**carrier**

An electromagnetic wave in which some feature is changed in order to transmit information.

**Carrier-Sense Multiple Access with Collision Detection (CSMA/CD)**

Protocol for channel access method used by Ethernet and IEEE 802.3 in which devices transmit only after finding the data channel clear for some period of time. When two devices transmit simultaneously, a collision occurs and the colliding devices delay their retransmissions for a random length of time.

**carrier symbol rate**

The number of symbols per second modulated onto the carrier.

**Carrier-to-noise ratio (C/N)**

A primary measurement of transmitted signal quality. In cable television, the ratio of peak carrier power to root mean square (RMS) noise power in a 4 MHz bandwidth or the ratio of the carrier level to the level of noise also found in the channel of interest. The measure of channel quality is expressed in decibels with respect to a bandwidth around the carrier frequency. C/N results for optical storage media are usually stated with respect to a 30-kHz bandwidth, which is much narrower than the bands usually used to carry video or digital information. As a result, C/N has value mostly as an arbitrary figure of merit with which everyone is familiar.

**cascade**

In the trunk system, the cascade is the number of amplifiers ordered sequentially from the headend. In the distribution system, it is the number of line extenders ordered sequentially from the bridging amplifier.

**C-band**

The band of frequencies ranging from 3.7 to 4.2 GHz (for downlink) and 5.7 to 6.2 GHz (for uplink).

**cell size**

A pre-determined area to be covered by a given system design.

**CFT2200**

GI's Consumer Friendly Terminal, analog set-top terminal used in the cable subscriber's home.

**channel**

A frequency band 6 MHz wide that carries a television signal. Each Channel carries one video and one associated audio signal (programming) at a time. (See also Display Channel, Output Channel, and RF Channel.) A portion of the spectrum assigned for the operation of a specific carrier and the minimum number of sideboards necessary to convey intelligence.

**channel combiner**

An electronic or passive device that accepts the radio frequency (RF) signals from many sources and combines them for transmission on the cable.

**channel map**

A list of frequencies corresponding to channel designations.

**channel mapping**

Allows customized tuning parameters to be given to a set-top terminal.

**character generator**

An alphanumeric text generator. Usually used to display messages on a TV set.

**characters per second (cps)**

A measure of transmission speed where a character refers to eight data bits and may include a start bit and one, one and one-half, or two stop bits.

**client/server**

A distributed system model of computing that brings computing power to the desktop, where users (clients) access resources from servers.

**clunk**

1.93 miles—Used for calculating the radius of blackout areas. Used only by DBS.

**coaxial cable (or coax)**

A type of cable that has two conductors sharing the same axis. Consists of a center conductor, insulating dielectric, conductive shield and optional protective covering.

**Code Division Multiple Access (CDMA)**

A spread spectrum technology that has been developed to increase capacity over analog technologies and allow more efficient use of the spectrum. Essentially, the technology works by spreading signals across the broad frequency spectrum and assigning a unique code to each. Receivers then pluck the properly coded signals out of the mix.

**Code Download Server (DLS)**

The General Instrument software application that, together with the DAC 6000, downloads IR Blaster and executable code objects to digital cable terminals. The DLS provides the message stream of code objects for the download to digital cable terminals. The DLS formats the objects as a message stream that is output continuously to the OM 1000 out-of-band modulator via the headend LAN.

**cold install**

The ability to install a Set-top terminal that is not pre-authorized. Also includes the ability to facilitate the Authorizations for that set-top terminal using a touch tone phone. See big hammer.

**collection**

Collection is the process of obtaining programming, generally associated with "network broadcaster" news.

**color burst**

In the NTSC color system, this refers to a burst of approximately nine cycles of 3.58 MHz subcarrier included in the composite video signal. This serves as a color-synchronizing signal to establish a frequency and phase reference for the receiver.

**combiner or combining network**

A passive network that permits the combining of several signals into one output with a great degree of insulation between each input.

**Commander-6 Upconverter (C6U)**

A GI device that provides frequency translation of the TV-IF output signal from the IRT.

**Commercial Integrated Receiver-Decoder (IRD)**

The device used by a headend to receive signals from a satellite. (See also IRD.)

**compatibility**

Ability of one device to interconnect with another. In data communications, compatibility requires devices to have the same code, speed, and signal level.

**Composite Second Order Beat (CSO)**

1. A clustering of second order beats 1.25 MHz above the visual carriers in cable systems.
2. A ration, expressed in decibels, of the peak level of the visual carrier to the peak of the average level of the cluster of second-order distortion products located 1.25 MHz above the visual carrier.

**Composite Triple Beat (CTB)**

1. A clustering of third-order distortion products around the visual carriers in cable systems;
2. A ratio, expressed in decibels, of the peak level of the visual carrier to the peak of the average level of the cluster of the third-order distortion products centered around the visual carrier;
3. The number of beats (distortion products) occurring in cable television broadband transmissions.

**compression**

Reduction in amplitude of one portion of a waveform relative to change in another portion of a waveform.

**compression ratio**

The ration between uncompressed (source) signal data rate and compressed signal data rate. The number of services carried per transport multiplex depends on the Compression Ratio, which in turn depends on desired program quality. The lower the ratio, the higher the bandwidth, and quality. Ex: 4-to-1 ratio for sports is needed to match the 10-to-1-ratio quality acceptable for films.

**Concatenated Trellis Error Correction**

Concatenated FEC (Forward Error Correction) is a technique where two types of FEC are used to protect transmitted data. Commonly, Trellis Coning and Reed Solomon encoding are used.

**concatenation**

The linking together of various data structures.

**conditional access table**

A table carried in the PID1 stream of a transport multiplex that lists the PID numbers of all EMM streams in a transport multiplex and indexes each EMM stream to an EMM provider ID.

**conductor**

A substance that controls or directs heat, light, sound or an electrical charge.

**connection ID**

A value assigned by the ASEM to identify a service. ASEM and the ITEM use the connection ID to activate or deactivate a service.

**Consultative Committee for International Telegraph and Telephone (CCITT)**

Former name for the international organization that is now called the International Telecommunication Union Telecommunication Standardization Sector, or ITU-TSS; the ITU-TSS develops communications standards, known as "Recommendations", for all internally controlled forms of analog and digital communication. Recommendation X.25 is an example of an ITU-TSS standard.

**Consumer Integrated Receiver-Decoder (IRD)**

The device used by a subscriber to receive signals directly from a satellite. (See also Integrated Receiver Decoder).

**Continuous Wave (CW)**

Used as a carrier to broadcast signals.

**controller**

A Device used to send instructions and signals to set-top terminal in a stand-alone environment (e.g. ACC 4000).

**controller (addressable)**

PC-based operating system for control of an addressable database that is communicated to addressable set-top terminals.

**controller event number**

A Cable Data term which is the same as Authorization Code Number.

**converter**

An analog Device that the Subscriber uses to receive programming on a cable system. It is the last Device used before the Product is consumed. The preferred term is set-top terminal.

**Cathode Ray Tube (CRT)**

A vacuum tube in which a hot cathode emits electrons that are accelerated as a beam through a relatively high voltage anode, further focused or deflected electrostatically or electromagnetically, and allowed to fall on a fluorescent screen.

**Cross Modulation (XM)**

A form of television signal distortion where modulation from one or more television channels is imposed on another channel or channels.

**cycle**

Alternating waves starting at zero amplitude, increasing to a maximum amplitude, decreasing to zero amplitude, further decreasing to a minimum value amplitude and finally increasing back to zero amplitude.

**Cyclic Redundancy Check (CRC)**

A form of error detection. Accomplished by reading a block of incoming data operating on the binary number equivalent of this block (e.g. dividing by another binary number) and noting the remainder. If this remainder is the same as a character transmitted in the message, it is assumed that the transmission was error free.

**DAC 6000**

Digital Addressable Controller 6000, Model of local control device manufactured by General Instrument. Controls analog and digital set-top terminals.

**Daemon**

A UNIX process that runs in the background.

**Data Collector (DC)**

A device that stores and accumulates purchase information from a customer's DCT 1000.

**Data Encryption Standard (DES)**

A standard cryptographic algorithm for the protection of data.

**Data Generator Interface (DGI)**

An application running on a host computer that downloads data to be multiplexed into the digital Data Stream.

**data path**

Refers to the equipment and data of the out-of-band control stream and return-path data streams.

**data rate**

In data communication, the speed of data transmission expressed in terms of bits per second (bps). Two prefixes are often used to shorten or abbreviate the data rate expressions: K for kilo, or times on thousand, and M for mega, or times on million. Thus one Mbps means one million bits per second. Sometimes, the data rate multiplier is assumed and is not stated in conversation, as in "fourteen dot four" (14.4 Kbps) or "nineteen dot six" (19.6 Kbps).

**data stream**

Information that flows from the access controller through digital headend equipment to the subscriber's DCT 1000. A character stream that carries Device instructions from the addressable controller to various headends. Also, the information being sent down the cable by the data path Device at the headends to the set-top terminals.

**dB (decibels)**

A unit that expresses the ratio of two power levels on a logarithmic scale. A unit of measurement expressed as the ratio of two power levels on a logarithmic scale. Equation: $dB = 10 \log_{10} P1/P2$

**dBc**

The ratio expressed in decibels, relative to the gain or loss to a reference carrier level. Example: The audio carrier level is referenced as being X dB below the visual carrier level, or X dBc.

**dBi**

The unit of measure for antenna gain that applies to both transmit and receive antennas. The term dBi measures gain in decibels above an isotropic radiator (a point source) and thus only theoretical. It provides a convenient measure of a real antenna's performance (gain) since it represents a unity gain transmission.

**dBm**

Decibel referenced to a milliwatt. Power levels at the reception and transmission sites are typically given in dBm. The level at any point in the system is expressed as dB above 1 milliwatt. Equation: dBm = 10 log [(power in mW)/(standard level of 1 mW)]

**dBmV**

Decibels referenced to a millivolt. Expression of signal amplitude. It is the ratio of the signal power in a 75-ohm system to a reference power when one millivolt is across 75 ohms. Typically, for cable television systems, the standard for measurement is referenced to the power corresponding to the applied voltage of 1 millivolt across a 75-ohm resistor. The level at any point in the system expressed in decibels above the 1-millivolt standard is said to be the level in dBmV. Equation: dBmV = 20 log [voltage in mV/standard level of 1 mV]

**DC**

(Direct Current) Flow of electrons in one direction that does not vary appreciably from a given value.

**DCT**

(Discrete Cosine Transform) A source coding technique for compression of digital video.

**decoder**

A Customer or Headend Device capable of decoding an analog Scrambled Service. The device used to restore a signal to its original format after it was scrambled or encoded.

**Decoding Time-Stamp (DTS)**

A field that may be present in a PES packet header that indicates the time that an access unit is decoded in the system target decoder.

**decryption**

The process of unscrambling an encrypted signal back into its original format.

**defining process**

Process that provides needed functionality for the Scheduler system

**delivery**

The unique combination of a Service and a Channel at one Headend is a Delivery.

**demodulation**

An operation to restore a previously modulated wave.

**demultiplex**

The reverse of multiplexing. The process of recovering many channels from one high-speed signal into which the channels were previously combined.

**density**

The mass per unit volume of a substance under specified or standard conditions of pressure and temperature.

**descramble**

A unique method that makes an unintelligible video signal intelligible.

**dielectric**

A non-conductive insulating material between the center conductor and shield of a coax.

**DigiCable™**

Technology for distribution of digital video, audio and text information.

**DigiCipher™**

Program delivery technology developed by General Instrument based on compressed and encrypted digital video.

**DigiCipher II™**

An Encoder/Compressor manufactured by GI that converts analog broadcast signals to digital and packetizes multiple services onto a single MPEG-II data stream.

**DigiNet**

A proprietary GI network connecting UCS with other DCII equipment. Similar to Ethernet, but has a higher throughput.

**DigiNet Protocol**

A proprietary GI protocol used for communications between GI products (DCII, IRTs, etc.). MPS and UCS communicate via an Ethernet-based network using TCP/IP protocol and DigiNet protocol on top of that.

**digital**

A method of storing, processing and transmitting information through use of distinct electronic or optical pulses that represent the binary digits (bits) 0 and 1. Pertaining to the class of devices or circuits in which the output varies in discrete steps (i.e., on/off operations or pulses).

**Digital Access Network Interface Server (DANIS)**

The General Instrument device that serves as a front-end subsystem of the DAC 6000 and generally off-loads it of time-intensive or real-time tasks.

**digital audio**

Audio programming represented in digital format.

**digital bypass**

The ability to bypass digital reception, allowing reception of analog services.

**digital cable terminal**

A device installed in a subscriber's home that accepts and decrypts digital and analog services for presentation on a supported receiver or output device such as a television.

**digital channel**

A frequency band 6 MHz wide allocated within a cable frequency bandwidth that carries the MPEG-II Transport Stream of multiple video, audio, data and text components. In cable usage, Digital Channels are aimed at MPEG-II capable set-top terminals. (See also Analog Channel.)

**digital circuit**

A fully digital connection for the transmission of voice or data, or both. A digital circuit generally offers higher capacity, has lower error rates, and is more reliable than an analog circuit.

**digital compression**

The reduction of storage space and/or transmission data rate necessary to store or transmit information represented in a digital format. Common digital compression methods include the suppression of long strings of 1s and 0s, delta transmission (sending only the difference between two sampled signals in successive period). For video applications, compression methods include matching the characteristics of picture quality to the limitations of the human eye.

**digital compression certification**

Signifies that a cable system is ready to deliver and maintain digitally compressed services.

**Digital Consumer Terminal (DCT 1000)**

Equipment installed in a subscriber's home that, when authorized, can be tuned to an incoming television signal to decode it and present a viewable output. It is also used to increase the channel load of the television set.

**digital cross-connect**

Cross-connects a variety of electrical and optical signals

**Digital Satellite System (DSS)**

Marketed under the name DirecTv.

**digital service map**

The table that identifies how digital services are distributed within the transport scheme, satellite, and cable.

**digital signal processor (DSP)**

A microprocessor that acts upon digital signals in any of a thousand ways. An extremely powerful device, in effect a step above a conventional microprocessor.

**digital transmission**

The sending of information represented by a finite number of signal states. For example, binary transmission has only two possible signal states, 64 quadrature amplitude modulation (64 QAM) has sixty four possible signal states. The advantages of digital transmission over analog transmission include better noise immunity, the ability to regenerate and re-time the signal to its original quality, and the relative ease of combining or multiplexing several signals.

**digital video**

Video signals represented in a digital format.

**digital-to-analog (D/A) converter**

Mechanical or electronic device used to convert discrete digital numbers to continuous analog signals.

**diplex filter**

A device that provides signal branching on a frequency division basis.

**Direct Broadcast Satellite (DBS)**

Direct-to-set-top terminal broadcast service.

**directional coupler**

A passive electronic device that couples a set value of RF energy from the input signal, allowing the remaining RF energy to pass through the output port.

**display channel**

The channel number that a subscriber sees displayed on the set-top terminal.

**distortion**

An undesired change in a signal waveform within a transmission medium. A non-linear reproduction of the input waveform.

**distribution system**

The part of the CATV system consisting of the trunk and feeder cables used to carry signals from the headend to subscriber.

**Dolby®**

Technology for coding of audio information; Dolby® Labs, Inc.

**Domain Name Server (DNS)**

Internet electronic-mail system for translating names of network nodes into addresses.

**downconverter**

Generally used in satellite receivers, the circuit that lowers a high frequency signal to a lower, intermediate range.

**downlink**

Satellite to earth transmissions.

**downstream**

The flow of signals from the cable system headend through the distribution network system to the subscriber set-top terminals. Transmitting the data stream from the addressable controller to headend equipment and set-top terminals. Downstream capability is required in all addressable cable systems.

**drop cables**

The cable that connects the feeder portion of the distribution system to the subscriber's home.

**DS-0, DS-1, DS-3**

Digital service levels 0, 1 and 3. DS-0 is the worldwide standard speed for one digital voice signal (64,000 bps). DS-1, in North America, equals 24 voice channels or 1.544 Mbps. DS-3 equals 28 DS-1 channels, or 44.7 Mbps.

**D-Tip Protocol**

Interface by which the billing system communicates with the AC and controls both analog and digital set-top terminals. Is a serial protocol that supports digital set-top terminals and functions and includes digital set-top terminal parameters. Translations from the D-Tip protocol to BSI RPC calls are done at a modified y-box. D-Tip supports current AC analog set-top terminal types, digital set-top terminal types & parameters, set-top terminal polling, report-back of purchases, diagnostic & non-responding data, and subscriber messaging.

**dual-up converter**

Headend equipment that converts IF signals from the IRT to usable television frequencies.

**dynamic event**

Events with beginning or ending times which may vary during Product Delivery (e.g. a live sporting Event).

**dynamic service**

A Service on which Events are provided.

**earth resistance meter**

A device used to measure resistivity in the ground.

**Earth Station Antenna (ESA)**

The device used to receive and transmit electronic signals between the earth and communications satellites.

**ECM**

Entitlement Control Message. A message describing the access requirements for a service. The DAC 6000 creates these messages for a service requiring encryption. The ITEM 1000 incorporates these message into the ECM data stream.

**EEPROM**

Electronically Erasable Programmable Read-Only Memory - A device that can be erased electrically and reprogrammed.

**egress**

In cable television, unwanted electrical signal leakage from a cable system.

**electron gun**

An electron emitting electrode and associated elements, especially in a cathode-ray tube, that produces a beam of accelerated electrons.

**Electronic Program Guide (EPG)**

The electronic listing of programs provided to the Subscriber via the set-top terminal.

**Elementary Stream**

One stream of a given type of unique data within a packet multiplex (MPEG-II). I.e., video, audio, text, data. Each elementary stream is uniquely identified within the stream by its Packet ID (PID). Also known as Packet Elementary Stream (PES).

**Embedded Control Messaging Stream**

Special data stream included as part of the satellite-received transport multiplex containing access control commands and messages typically received from a local access controller.

**Emergency Broadcast System (EBS)**

A voluntary plan coordinated by the Federal Communications Commission for broadcasting of emergency information. Under this plan, radio and television stations agree to give up their regular programming in the event of a local, state, or national emergency.

**EMM Provider ID**

Unique number that identifies the source of encryption for a data stream. Used in conjunction with the unit-addressed EMM to enable a GI TSODA to decrypt an encrypted data stream.

**encoder**

Equipment used to convert data by scrambling or digitizes programming signals and applying a key for encoding each channel.

**encoder hit**

A process which enables or re-enables scrambling on a selected Encoder or Encoders.

**Encoder Management System (EMS)**

Allows users to view the activity and state of the TSPs within an Encoder.

**encryption**

The operation performed on a data stream that prevents its use by unauthorized terminal devices attached to the system. Encryption is a digital process inherently applied to digital signals. (Note: encryption is not the same as scrambling.)

**Encryption Engine Element (EEE)**

Element that provides the system security handling on the encoder and key server. See TSODA for more information.

**encryption key**

One of two keys (7-bits standard, 28-bits enhanced) maintained by the addressable controller and sent to downstream terminals. They are used primarily to decrypt incoming tag data placed onto a service's RF signal.

**Enhanced Pay-Per-View (EPPV)**

PPV programming with numerous start times. Also known as Dynamic Pay-Per-View.

**Entitlement Control Message (ECM)**

A message describing the access requirements for a service. These MPEG-2 formatted messages carry service component information such as Working Keys and Program Keys; a message describing access rights of a program. The DAC 6000 creates these messages for a service requiring encryption. The ITEM 1000 incorporates these messages into the ECM data stream.

**Entitlement Management Message (EMM)**

A message enabling digital terminals to decrypt a service. These MPEG-2 formatted messages carry system wide information such as Category Keys to specific set tops, a message delivering authorization privileges and related access control information to a specific DCT 1000 or group of DCT 1000s. The DAC 6000 inserts these messages into the EMM data stream that is distributed out-of-band.

**entry connector**

A type of distribution cable connector utilized to connect the cable to an active or passive device in the network. See feed-thru an pin connector.

**EPG inserter**

An add/drop multiplexer that inserts EPG data in the out-of-band data stream

**epoch**

The defined lifetime of a given key.

**equalization**

1. A means of introducing tilt into the response of an amplifier or other device to compensate for slope caused by the frequency vs. Attenuation characteristics of coaxial cable. 2. Adjustment of the frequency response of an amplifier or network so that it will affect all signal components within a specific bandwidth to result in a desired overall frequency response. Means of improving circuit quality by equalizing different distortions; may be a function of a modem.

**equalizer**

A passive device or circuit with a tilted frequency response opposite that of the cable preceding it, to compensate for the response of the cable.

**error burst**

A sequence of transmitted signals containing one or more errors occurring within a short period of time, compared to the average incidence of errors; a sequence of errors sufficient to cause loss of synchronization between sending and receiving stations and requiring re-synchronization.

**error control**

A system that detects and corrects errors in transmitted data.

**error rate**

The ratio of the number of characters of a message or data stream incorrectly received to the number of characters of the message or data stream received. The probability that a bit, character, or block is in error within a given sample size.

**Ethernet**

IEEE standard network protocol that specifies how data is placed on and retrieved from a common transmission medium. Has a transfer rate of 10 Mbps. Forms the underlying transport vehicle used by several upper-level protocols, including TCP/IP and XNS. See CSMA/CD for a description of Ethernet's media-access method. Compare with Token Ring.

**Ethernet hub**

An Ethernet network used to control interaction and data flow between digital headend devices.

**event**

Program of limited duration (e.g. a movie or concert) that appears at a particular time and date on a particular Service. A single pay-per-view service provided to cable subscribers beginning at a specified time and lasting for a pre-determined interval.

**event authorization**

A process wherein a terminal receives permission to decode a signal on a cable channel beginning at the event's specified time and lasting for the duration of the event. Each event is identified by its Service Code.

**event number**

A system-wide unique identifier for an Event.

**event packages**

A Package, which consists of one or more Events, offered for sale to the Subscriber.

**event tag number**

A GI specific Service Code used by set-top terminals to recognize authorization of an Event.

**event types**

A specific type of Event: Normal, Periodic, Multiple Channel, Premium Service, Dynamic and Special.

**expansion loop**

A type of loop formed to compensate for expansion or contraction caused by temperature.

**extended basic**

An extended tier of services, in addition to Basic, offered to the subscriber for an additional fee.

**F connector**

A type of connector that connects coaxial cable to equipment.

**Fabry-Perot Return Laser**

A low power laser utilized for the transmission of data signals from the network back to the headend.

**face plate**

The plate containing the electronics that can be disconnected from the mechanical housing in taps, splitters and directional couplers.

**facilitate**

Process data as “throughput;” receive from one source and send to an entity without changing the data.

**fading**

1. A fast or slow deterioration of signal quality caused by increasing loss in an electromagnetic propagation path. 2. A gradual decrease (fade-out) or increase (fade-in) in the brightness level of an image.

**fast Ethernet**

A 100 Mbps technology based on the 10BASE-T Ethernet CSMA/CD network access method.

**Federal Communications Commission (FCC)**

U.S. Government agency that was established to regulate the electronics industry.

**feeder cable**

Coaxial cables that takes signals from the trunk line to the subscriber area.

**feederline equalizers**

An equalizer mounted in a tap housing installed in the feeder (distribution) cable to reduce the low channel signal.

**feed-thru connector**

A distribution cable connector which allows the cable to “feed thru” and the cable center conductor to be accessed directly for connections.

**fiber optics**

Hair-thin glass fibers that allow light beams to be bent and reflected with low levels of loss.

**Field Addressable Management Systems (FAMS)**

A subsystem created to decentralize the scheduling and management of PPV and Special Events.

**File Server Interface (FSI)**

Extracts user-selected MPEG-2 transport streams and services and performs timebase recovery to remove network hitter, and encrypt and re-multiplex the services onto a single DCII encoder-compatible DS3 output transport multiplex.

**File Server Interface Controller (FSIC)**

Configures and controls the FSI(s) and initiates the delivery of Entitlement Management Messages to commercial IRDs and IRTs.

**fingerprinting**

The process of visibly displaying the IRD unit address on the active portion of a video signal.

**firewall**

Separate hardware/software that acts as a B-1 level security gateway between the NDTC database(s) and external entities.

**flash EPROM**

PROM (Programmable Read-Only Memory) technology providing nonvolatile storage that can be electrically erased in the circuit and reprogrammed; developed by Intel and licensed to other semiconductor companies.

**flat bottom loop**

A loop installed in distribution cables to compensate for weather changes (expansion and contraction).

**flatness board**

An electronic network used in amplifiers to change the signal frequency response to compensate for cable response and amplifier signature.

**FM Modulator**

Converts baseband TV signals to an intermediate frequency (IF).

**footprint**

The area of the earth's surface to which a satellite transmits.

**forward error correction (FEC)**

An encoding technique applied to data before transmission to reduce the number of errors introduced by transmission. The receiving device decodes the FEC to recover the original data. The technique used for improving the accuracy of data transmission. Excess bits are included in the outgoing data stream so error correction algorithms can be applied when it is received. In data communication, the formatting of data with extra error detection and correction bits at the sending end of a transmission. The bits are used, upon reception, to detect and correct a finite number of transmission errors. This is the method used as an alternative to data re-transmission when an error is detected. A recovery procedure in which the receiving hardware analyzes bit patterns and corrects small errors, without requiring re-transmission of the block containing the errors.

**frame**

In image technology, refers to one complete screen image in a timed sequence of images. An NTSC frame consists of 525 video lines visible for 1/30th of a second displayed as two interleaved fields of 1/60 second each.

**frame rate**

The rate at which images in a motion image sequence are displayed on a screen. Broadcast video is displayed at 30 frames per second, film at 24 frames per second.

**frequency**

The number of vibrations per second of an electromagnetic signal, expressed in cycles per second, or Hertz. The number of times an electromagnetic wave repeats an identical cycle in a unit of time (usually one second). One Hertz (Hz) is one cycle per second. A kHz (kilohertz) is one thousand cycles per second; a MHz (Megahertz) is one million cycles per second; a GHz (GigaHertz) is one billion cycles per second.

**Frequency Division Multiple Access (FDMA)**

Carves up telephone channels by frequency, instead of time (i.e., TDMA) and assigns specific frequencies for each user, as opposed to CDMA).

**frequency mapping**

1. A table that defines a specific channel and its related RF Frequency in the set-top terminal.
2. For GI international set-top terminals, a table sent out to define the tuned Channel and its related RF Frequency and spacing.
3. In an IRD, a table that defines the tuned Channel and its related L-Band frequency.

**frequency range**

That range of frequencies over which a device performs or meets its specifications.

**frequency response**

The gain versus frequency characteristic of a circuit, device, or network.

**frequency-agile**

The ability to easily tune to other frequencies.

**front end**

TCI Addressable Control System Product Delivery subsystem (includes a Database). This term is used in reference to the current TAC system only.

**FSK**

(Frequency Shift Keying) A type of frequency modulation in which the signal shifts the output signal between pre-determined values. Also, a type of signaling in which various frequencies are used to represent different characters to be transmitted.

**FTP**

File Transfer Protocol - Upper level TCP/IP service allowing files to be copied across a network.

**full-motion video**

A description of the video capability of a teleconferencing system. An older term that was used to indicate that a system had some degree of video support, not just still picture or still image support. May or may not indicate smooth video motion.

**full-service package**

Package that contains all Events offered on a Service.

**functions**

set-top terminal actions performed one time as a result of an instruction sent to the set-top terminal (e.g. Initialize or Clear Parental Guidance. (See also Features).

**fusion splice**

A technique of joining two pieces of optical fiber together.

**gain**

A measure of amplification, usually expressed in dB. The gain of a CATV amplifier is usually specified at the highest frequency of operation. The amplification amount of input to output power, generally expressed in decibels.

**gain distortion**

Distortion that results when all of the frequency components of a signal are not transmitted with the same gain or loss. Also known as frequency distortion.

**geostationary**

Describes a satellite in orbit 22,300 miles above the equator that revolves around the Earth with an angular velocity equal to that of the Earth's rotation about its own axis. The satellite's position relative to the Earth's surface is constant (stationary), so little or no ground antenna tracking is needed. Also known as geosynchronous.

**ghost**

A weak image of the received picture, offset either to the left or right of the primary image, which is the result of transmission conditions which create secondary signals which are received earlier or later than the primary signal. A ghost displaced to the left of the primary image is designated as "leading," and one displaced to the right is designated as "lagging." When the total variations of the ghost are the same as the primary image, it is designated as "positive"; when it is the reverse, it is designated as "negative."

**GigaHertz (GHz)**

One billion cycles per second.

**glitch**

1. A narrow horizontal bar moving vertically through a television picture. 2. A short duration pulse moving through the video signal at an approximate reference black level on a waveform monitor. 3. A random error in a computer program. 4. Any random, usually short-term unexplained malfunction.

**global event cancellation**

The process of de-authorizing an Event at the Headend and performing a global set-top terminal de-authorization for each Customer through a Device dependent recognized command.

**global tag**

A Tag that is automatically assigned to an Event allowing a global Purge of the Event afterwards, rather than a separate Purge from each set-top terminal. Must be used for the same Event on all Headends.

**Graphical User Interface (GUI)**

An application programmer interface that supplies a tool set to easily build and manipulate graphical displays for users to interact with. These displays have pre-defined windows, buttons, help facilities, etc. and are used to present menus, forms, and display information to the user.

**ground**

An electrical connection or common conductor that, at some point, connects to the earth.

**ground grid**

A system of interconnected bare conductors arranged in a pattern over a specified area and on or buried below ground level, the purpose of which is to provide a ground potential.

**grounding rod**

A 5/8" x 8' copper-clad steel rod that is driven into the ground to provide an electrical ground for the drop cable or is used as an electrical ground for the cable plant, typically at amplifier locations, power supplies, etc.

**ground wire**

A copper wire used to connect the ground block at cable drops and the cable plant to a suitable ground.

**grounding block**

A device that is used in the drop cable to provide the means to connect an electrical ground. It consists of an F-81 barrel connector and a lug for attaching a ground wire.

**group delay**

1. The phase delay of the envelope as defined by all of the frequencies within the channel bandpass as it passes through a circuit or network. Group delay is usually very close in value to envelope delay and transmission delay, and in the case of vanishing spectrum bandwidth of the signal these quantities become identical. 2. In the propagation of electromagnetic signals consisting of several frequencies, the difference in propagation transmission times between the highest and lowest frequencies through a device or circuit.

**guard band**

A frequency band between two channels, which gives a margin of safety against mutual interference.

**Harmonically-Related Carriers (HRC)**

A cable plan where each video carrier is a perfect multiple of 6 MHz. This technique is used to mask composite triple beat distortion by zero-beating those distortions with the video carriers.

**headend**

An electronic control center of the CATV system where incoming signals are amplified, processed, and combined for transmission to subscribers.

**Headend Configuration Tool (HCT 1000)**

A General Instrument Inc. PC-based tool for provisioning network devices in a digital CATV headend or broadband interactive network. The HCT 1000 helps set up embedded code images, assign IP addresses to network devices, and set up start-up parameters.

**Hertz (Hz)**

The unit for measuring the frequency with which an alternating electromagnetic signal cycles through the zero-value state between lowest and highest states. One hertz (abbreviated Hz) equals one cycle per second. Frequency measurement in hertz is employed to define the bands of the electromagnetic spectrum that are used in voice and data communications, or to define the bandwidth capacity of a transmission medium.

**heterodyne**

Combining two carriers to create a new carrier (sum or difference of the original carriers) or using a local oscillator to shift a carrier frequency.

**high channel input level**

The signal level of the highest channel measured at the input to the electronic device (amplifier, tap etc.)

**High Definition Television (HDTV)**

The next generation standard for what is generically called “Advanced Television” with a resolution of about 1,000 lines/frame and about 1,400 pels/line.

**high pass filter**

A filter that passes frequencies above a given frequency and attenuates all others.

**High Power Amplifier (HPA)**

A device that amplifies an upconverted signal. It is used at the uplink to produce sufficient power for transmission to the satellite.

**High Speed Cable Interface (HSCI)**

The physical interface on the back of the DCT that delivers the currently “tuned” MPEG transport.

**High-Speed Transport Multiplex (HSTM)**

A self-defining, MPEG-2 compliant, packet-based digital data stream composed of multiple services plus PID0 and PID1 control streams.

**hot install**

When a set-top terminal is installed at Subscriber Location, which has already been Initialized and set up with Services, the set-top terminal is operational.

**HTML**

HyperText Markup Language - The official language of the World Wide Web.

**hub**

One or more headends located at satellites to a central headend. In large population centers, transmitting signals by microwave links to hubs may be more economical than a trunk line. Hubs are not as complex as the central headend, since they merely relay and distribute the signals.

**Huffman Coding**

The technique where variable length is used to reduce the overall amount of data needed to represent a given amount of information. The length of a code word is determined by the relative probability of its occurrence. Thus, the most frequently used words get the shortest length.

**iconoscope**

A television camera tube equipped for rapid scanning of an information storing , photoactive mosaic.

**IEEE**

Institute of Electrical and Electronic Engineers - An international professional society that issues its own standards and is a member of ANSI and ISO.

**impedance**

The total opposition to AC electron current flow within a device. This includes a resistive element and a reactive element. This characteristic is expressed in ohms and is typically 75 ohms for coaxial cable and other components used in the CATV industry.

**impediment**

Impediment within this context means any blocking of the video signal, either through the output of 0 IRE in the active video portion of the signal or text superimposed upon the black background.

**Impulse Pay Per View (IPPV)**

Two-way, real time impulse purchasing of PPV products.

**In-band Modulator (IM 1000)**

The General Instrument Inc. IM 1000 links the digital headend equipment with the distribution system by converting a digital input stream to an IF output signal that can be upconverted and distributed.

**in-band transport**

Where DCT messages are delivered on multiple transport streams also containing program elementary streams. (Typical DCII transport mode.) All DCTs receive some of their control messages via in-band transport.

**Incremental Coherent Carriers (ICC)**

A cable plan in which all channels except 5 and 6 correspond with the standard channel plan. The technique is used to reduce composite triple beat distortions. Synonymous with ICC (Incrementally Related Carriers).

**Incrementally Related Carriers (IRC)**

A cable plan in which all channels except 5 and 6 correspond with the standard channel plan. The technique is used to reduce composite triple beat distortions. Synonymous with ICC (Incremental Coherent Carriers).

**independent service**

A feature of cable service in which different set-top terminals can have different authorizations in one subscriber site.

**infrared**

The frequency range used for hand held wireless remote controls.

**ingress**

The unwanted interfering radio frequency (electrical) signals into a cable television system. Contrast with egress.

**initialization**

The process by which digital headend network elements obtain configuration information and operating parameters at power up.

**insertion gain**

A change in signal level, expressed in decibels, caused by the inclusion of a circuit, circuit section, or item of equipment in a network.

**insertion loss**

The loss incurred when a device such as a directional coupler is inserted into a circuit. It is equal to the difference in signal level between the input and output of such a device (in dB).

**Instrument Society of America (ISA)**

The 16-bit bus design used for Intel-based personal computers.

**Integrated Circuit (IC)**

An electronic circuit made by manipulating layers of semi-conductive materials.

**Integrated Receiver Decoder (IRD)**

A headend or consumer device that receives digital satellite signals and decodes them for viewing.

**Integrated Receiver Transcoder (IRT 1000\2000)**

General Instrument Inc. digital headend equipment (IRT 1000\IRT 2000) that receives digital satellite signals and remodulates data from QPSK to QAM for cable plant transmission in the IF mode.

**Integrated Services Digital Network (ISDN)**

An international standard for dial-up digital transmission over a public telephone network. Its stated purpose is to deliver more bandwidth to the end user than analog by moving the signaling out of band and deliver a host of new services to users. ISDN uses a Basic Rate Interface and Primary Rate Interface. The BRI, also known as "2B + D," consists of two bearer channels and one data channel. Each bearer channel represents a 64 kbps channel and each data channel represents a 16 kbps signaling and control data stream. The PRI, also known as "23B + D," features a 1.544 Mbps data stream. In Europe, the PRI is a "30B + D" data stream of 2.048 Mbps. Signaling System 7 is key to ISDN's future because it removes signaling from the network and puts it on a separate packet switching network. The first ISDN call placed in this country occurred in 1986, but has yet to catch on widely. (CED 4/94)

**Integrated Transport Encryption Multiplexer (ITEM 1000)**

General Instrument Inc. cable headend hardware component that provides a junction point between digital service providers and cable subscribers. It processes a concentrated optical input containing information from many providers and encrypts and distributes multiple serial output streams.

**interface**

A shared boundary between elements in a system defined by common physical interconnection characteristics or signal characteristics.

**interference**

Any undesirable signal or distortion which tends to interfere with the reception of a desired signal (such as aircraft fading, RF beats, or “ghosting” from reflecting objects such as mountains or buildings).

**Intermediate Frequency (IF)**

The frequency produced in a heterodyne circuit when a local oscillator’s frequency is mixed with the incoming RF signal. In a receiver, the resulting frequency after down-conversion and before modulation.

**intermodulation**

The modulation of the components of a complex wave by each other, as a result waves are produced that have frequencies equal to the sums and differences.

**intermodulation distortion**

Non-linear distortion in a system, characterized by the appearance of frequencies equal to the sums and differences of integral multiples of frequencies present at the input. Harmonic components also present in the output are usually not included as part of intermodulation distortion.

**Internal Owner**

Category to which “ownership” of a set-top terminal is assigned (e.g., Internal Owner of field is used for Subscribers). Internal Owners are used to identify default set-top terminal status coupled with available Authorizations.

**internet**

The world's largest inter-network, comprising large backbone nets (MILNET, NSFNET, and CREN, for example) and an array of regional and local campus networks worldwide. It uses the Internet protocol suite. Access to the Internet requires IP connectivity, or the ability to Telnet to -- or PING -- other systems.

**Internet Service Provider (ISP)**

Commercial organization that provides Internet access to individuals and organizations; for example, CompuServe and America Online.

**interoperability**

The ability of computers and programs from various vendors to operate together. Also used to denote the ability of differing systems or elements to interoperate or operate together to some degree.

**interoperable**

Non-proprietary. Open to use by external entities (e.g., the system will be useable by any make or model of set-top terminal).

**Interoperable Network Technology System (INTS)**

The INTS provides a high speed digital pipeline to deliver Services and information including required data to control and operate the digital cable network.

**interstitial**

Time between purchasable broadcast Events.

**intrusion detection**

A system that detects the intrusion/motion of unauthorized personnel and alerts the proper party for response.

**Internet Protocol (IP)**

In TCP/IP, the standard for sending the basic unit of data, an IP datagram, through an Internet.

**IP address**

Internet Protocol address. A public standard address used for packet- and connection-type communications.

**IPG**

Interactive Program Guide, a TV-Guide type service developed by NLS, to be provided via some NLS set-top terminals. Note that EPG is a similar service owned by another company; EPG is also provided via some NLS set-top terminals.

**IR Blaster**

A transmitter used to transfer data via infrared to a peripheral device, such as transmission from a hand held wireless remote control to a television or set-top terminal.

**Isonchronous**

Defines the characteristics of the clock that is associated with synchronous data. An isochronous clock has a jitter specification that defines position of the edges of the clock at any instant in time. In general, the assumption is that a PLL can be designed for a correctly specified isochronous clock, where this may not necessarily be the case for a synchronous clock.

**K Factor**

A rating factor given to TV transmission and reproducing systems to express the degree of subjective impairment of the TV picture.

**KeyList Server (KLS)**

Equipment located in the cable headend used to deliver encrypted keys to headend and distribution devices.

**Kilohertz (kHz)**

1,000 hertz (Hz) or 1,000 cycles per second (cps). Normally applied to analog signals.

**Klystron**

A velocity-modulated tube comprising, in principle, an input resonator, a drift space, and an output resonator. Commonly used in AML microwave transmitters.

**Ku-band**

The microwave frequency band approximately between 11 and 13 GHz used in satellite broadcasting. Frequency band from 11.7 to 12.7 GHz used for a variety of satellite communications services. One of the differences between KU-band and C-band satellite communications is that the satellite dish needed to receive KU-band transmission is typically only about three to four feet across, compared to the C-band dish that is several yards across.

**L-band**

RF frequency band from 950 to 1450 MHz.

**lightning arrester**

A device that attempts to route the power generated by a lightning strike to an earth electrical ground.

**linear distortion**

Distortion resulting from a channel having a linear filter characteristic different from an ideal linear low-pass or band-pass filter; in particular, amplitude characteristics that are not flat over the pass band and phase characteristics that are not linear over the pass band.

**local access programming**

In cable, video programming provided by local government or schools, and sometimes produced by a local cable operator, to benefit the community.

**Local Control**

The ability to control authorization of set-top terminals and services in a cable system from a local site, preferably the system headend.

**log files**

Files containing history of processes or errors that occurred while processes were running. These files can be useful in tracing problems.

**loop-back**

Sending a signal back to the transmitter. This can be done electrically or physically at several different points.

**loop-back device**

A network device, often at a customer location, that, on command, intercepts received messages and re-transmits them back into the network. The device is used to troubleshoot suspected or reported network problems. If, for example, a diagnostic signal can be received and re-transmitted back to the network, then network operations personnel can eliminate many network segments as possible sources of failure.

**lossless**

When data is decompressed all of the original data can be recovered.

**lossy**

Discarding information and relying on human perception characteristics to minimize the effects of the data reduction, i.e. not sending some high frequency information that represents very fine detail. Or limiting the amount of data used for chrominance (color) since humans are more sensitive to changes in luminance (intensity).

**low channel input level**

The amplitude of the lowest system channel at a given point in the network.

**Low Noise Amplifier (LNA)**

A low noise signal booster used to amplify the weak signals.

**Low Noise Block Downconverter (LNB)**

A microwave amplifier and converter that modifies a block or range of frequencies simultaneously to an intermediate frequency range, typically 950 to either 1450 MHz or 1750 MHz.

**low pass filter**

A filter that passes all frequencies below a specified frequency and blocks those frequencies above the specified frequency.

**MacroVision®**

The encoding technology that alters video data to disable VCR recording of an event.

**Media Access Control (MAC)**

This is the lower sub-layer of the Data Link layer in the ISO OSI model and is used to describe the mechanisms used to arbitrate access to a shared medium.

**MAC address**

A proprietary address used for upstream/downstream communications.

**Megabyte (Mb)**

A unit of measurement equal to 1,024 x 1,024 bytes, or 1,024 kilobytes; 8 million bits.

**Megahertz (MHz)**

Unit of frequency equal to one million cycles per second.

**message**

A data structure that is of variable length, starting with a type byte and ending with a CRC. Messages may be shorter or longer than a transport packet, but are typically shorter than a PES packet.

**message-level multiplexer**

A headend device allowing for the insertion of messaging on a packet level.

**message stream**

A flow of contiguous messages.

**microwave**

The point-to-point transmission of signals at high frequencies. Usually above 2 GHz.

**microwave transmitter**

The device used to relay signals from one tower to another.

**Millions of Instruction Per Second (MIPS)**

A measure of the computing power measured in terms of the number of instructions it can execute in seconds.

**modem**

A device that converts data from one form into another, such as from one usable in data processing to one usable in telephonic or RF transmission.

**Modulating Video Processors (MVP)**

A type of GI scrambler.

**modulation**

The controlled variation of frequency, phase and/or amplitude of a carrier wave of any frequency in order to transmit a message.

**Motion Pictures Expert Group (MPEG)**

An international standards setting group working to develop standards for compressed full-motion video, still image, audio, and other associated information.

**MPEG-2**

An international standard (ISO/IEC 13818) for delivering compressed digital video. MPEG-2 is broadcast quality at 704x480 pixels at 30 frames per second (fps) in North America and 704x576 fps at 25 fps in Europe. MPEG-2 is typically compressed at higher than 5Mbs and intended for higher quality broadcast uses.

**Multi-channel Multi-point Distribution Service (MMDS)**

A wireless service with the capability of transmitting more than one TV signal. Also known as wireless cable.

**Multimedia Cable Network System (MCNS)**

In 1994 several MSOs formed a holding company (MCNS). The committee was established for the purpose of creating a standard specification for data communications over HFC networks. The group divided specifications into different phases and worked with the vendor community to develop a "safe" specification that would provide the industry interoperability and ultimately a retail-driven market.

**Multi-path fading**

Found with AML or broadcast transmissions. Occurs when atmospheric conditions or other causes attenuate the main transmission signal or boost the reflected signal to the point where they cancel each other out, thus causing a partial or complete loss of signal at the receiver.

**multiple channel events**

Events that are carried on more than on channel (e.g., an Olympic Events Package).

**Multiple System Operator (MSO)**

A company that owns more than one cable television system.

**multiplexer (MUX)**

A device that combines and carries multiple signals simultaneously.

**multiplexing**

A function that permits two or more data sources to share a common transmission medium such that each data source has its own channel.

**multi-splits**

Distributing signals in a multitude of directions.

**N/C**

No connection, i.e., open circuit.

**narrowband**

A relative term referring to a system that carries a narrow frequency range (sometimes used to refer to frequency bandwidths below 1 MHz). In a telephone/television context, telephone would be considered narrowband (3 kHz), and television would be considered broadband (6 MHz). Contract to Broadband.

**National Cable Television Association (NCTA)**

The major trade association for the cable TV industry.

**National Control**

The ability to control authorization of set-top terminals and services in several cable television systems from one central site. Contrast to Local Control.

**National Electric Safety Code (NESC)**

Safety regulations and procedures issued by the American National Standards Institute (ANSI) to safeguard persons during the installation, operation and maintenance of electric supply and communications lines.

**National Technical Standards Commission (NTSC)**

Industry standard video television signal. 525 interlaced lines scanned at a horizontal rate of 15,734 Hz and a vertical field rate of 59.94 Hz. The color sub carrier of 3.58 MHz contains hue and amplitude (saturation) information.

**Near Video On-Demand (NVOD)**

Provides subscriber-controlled PPV services. Control is similar to VCR functions such as FF, REW, or pause.

**network criteria**

Essential information about the network.

**Network Data Processor**

Component of INTS that multiplexes data into the autoband stream.

**Network Driver Interface Specification (NDIS)**

Specification for a generic, hardware- and protocol-independent device driver for network interface cards. NDIS provides protocol multiplexing so that multiple protocol stacks can be used at the same time in the same computer.

**network performance**

The measurement of noise levels, composite triple beat and cross modulation at the extremity of the network stated in dB.

**network services**

Video, audio, or data programs delivered in MPEG-compliant packet-based digital data streams. Each network service is comprised of one or more elementary streams plus a control stream that specifies all streams in the service. If the network service is encrypted for access control, it might also include an ECM data stream describing the access requirements for the service.

**Network Termination Device (NTD)**

A device mounted on the side of the premises where telephony signals are coupled/decoupled from the broadband network.

**node**

A branching or exchange point in the network where light is converted to electrical energy.

**node launch amplifier**

The electronic amplifier located immediately after the light/electrical conversion takes place.

**node spotting**

Locating the node placement based upon customer serving.

**noise**

Unwanted or erroneous signals present on a medium or communication channel. Noise interferes with detection of the information on the channel or medium. Static on a telephone line is an example.

**Nyquist**

A standard data sampling frequency equal to two times the highest frequency in the sampled signal. Used to avoid aliasing in the sampled data.

**OAM&P**

Operation, Administration, Maintenance, and Provisioning. The OAM&P port is a network (Ethernet) port through which a device communicates with the headend network. The OAM&P port is assigned a hardware (MAC) address at the factory; this MAC address is used for communication with the bootp server before the port's network (IP) address has been assigned.

**ODVARC**

A demultiplexer and on-screen graphics chip.

**ohm**

A measure of the electrical resistance of a circuit. If the resistance of a circuit is one ohm, one ampere of electrical current will flow through the circuit when a potential difference of one volt is impressed across it.

**Ohm's Law**

The relationship among voltage, current, and resistance stating that the voltage drop across a resistor is equal to the product of the resistance of the resistor ® and the current (I) flowing through the resistor.

**one-way**

No Return Path used. Downstream data only.

**Out-of-Band (OOB) Transport**

Where messages are delivered on an independent stand alone transport stream, separately tuned and modulated. (DCTs with out-of-band capabilities usually receive control messages both in-band and out-of-band.)

**Operational Support Systems (OSS)**

A relational database used by telcos to deliver services, charge billings and interact with the network.

**Operations Center**

Provider of national access control, located at the NDTC. Formally known as TAC; also known as HITS Op Center.

**Optical Carrier (OC)**

The optical specification over SONET. An OC level is the optical equivalent of an STS signal. Transmission rates are based on 51.84 Mbps (OC-1). A c following an OC level identifies concatenation of payload (for example, OC-3c).

**optical couplers**

A passive component used to split or divine the optical power for distribution to receive nodes.

**optical hub location**

A point in the distribution network where the optical signal is received.

**optical receiver node**

Location in the network where optical light energy is detected and converted to RF energy.

**optical transmitter**

An electronic device that connects electrical energy to light.

**Optical Transition Node (OTN)**

An environmentally controlled enclosure containing an Optical Receiver and Transmitter. A fiber-optic repeater.

**OSI reference model**

Open Systems Interconnection reference model - Seven-layer network architecture model of data communication protocols developed by ISO and CCITT. Each layer specifies particular network functions: Layer 7, the application layer, the highest layer of the model, defines the way applications interact with the network. Layer 6, the presentation layer, includes protocols that are part of the operating system, and defines how information is formatted for display or printing and how data is encrypted, and translation of other character sets. Layer 5, the session layer, coordinates communication between systems, maintaining sessions for as long as needed and performing security, logging, and administrative functions. Layer 4, the transport layer, controls the movement of data between systems, defines protocols for structuring messages, and supervises the validity of transmissions by performing error checking. Layer 3, the network layer, defines protocols for routing data by opening and maintaining a path on the network.

**output channel**

The Channel that the television must be tuned to in order to receive set-top terminal signals.

**output converter**

An electronic device that up converts an intermediate frequency to a desired frequency. Generally the output stage of a headend modulator or processor.

**owner profile**

The set of default Features, Functions, Authorizations, and Packages assigned to any specific category of Office Owner.

**packet**

A collection of contiguous bits of data. Each packet has a header that defines the attributes of the information in the packet. DigiCipher II packet format follows the MPEG format of a 188-byte data structure consisting of a short header field followed by a longer data (payload) field. Also called transport packet.

**packet identifier (PID)**

A component of the MPEG specification. A number assigned to MPEG transport packets to identify the information stream to which they belong. The PID number is assigned in the packet header, and all packets from the same stream have the same PID number.

PID0 provides multiplex definition information for a transport multiplex (SSTM or HSTM). The PID0 stream carries the service association table. PID1 points to data streams containing access control information for an HSTM.

**packet stream**

A sequential flow of packets.

**Packetized Elementary Stream (PES)**

A data stream composed of end-to-end PES packets, which are variable length and typically far longer than a transport packet.

**pad**

A flat loss device used to alternate signals at an amplifier.

**passive device**

Static in operation, not capable of amplification or oscillation, requires no power to function. For example, splitters, taps, coupler, attenuators.

**Pay-Per-View (PPV)**

Used in cable TV programming where the user is charged a price for individual programs.

**persistence of vision**

When viewing the two fields that make up a television image, the brain "memorizes" the first field, and because the two consecutive fields follow each other in such rapid sequence, the brain sees a complete frame or picture instead of two separate fields.

**phase**

A fraction, expressed in degrees, of one complete cycle of a waveform or orbit.

**phase distortion**

Lack of direct proportionally of phase shift to frequency over the required frequency range.

**Phase-Lock Loop (PLL)**

An electronic servo system controlling an oscillator so that it maintains a constant phase angle relative to a reference signal source.

**phase modulation**

A form of modulation where the phase of the transmitted signal is changed as the value of the information changes.

**Phase Shift-Key**

A form of modulation where digital information is conveyed by changing the phase of the signal.

**Phased-Array Antenna**

A radio frequency (RF) transmission and/or reception antenna that uses several smaller antenna elements to create special transmission and/or reception characteristics. For example, phased-array antennas, used in radar applications, create one or more “pencil beams” to track specific targets, without the use of traditional radar rotating elements. Or, phased-array antennas (arranged in a flat configuration) can replace cumbersome parabolic antennas. Special electronics are used to control and combine the multiple signals to and from each antenna element. Phased-array antennas are much more expensive than many other types of antennas.

**Phase-Locked Modulator**

Permits fixed modulator output to be phase locked to an interfering local off air station, resulting in significantly reduced or eliminated interference.

**photodetector receiver**

An optical detector

**pilot carrier**

Signals on cable television systems used to operate attenuation (gain) and frequency response (slope) compensating circuitry in amplifiers.

**pilot subcarrier**

A subcarrier serving as a control signal for use in the reception of the stereophonic broadcasts.

**pilot tone**

A modulated or unmodulated tone used in lieu of video carriers to control automatic gain and slope control circuitry in CATV amplifiers.

**PING**

Packet INternet Grouper - A utility program used to test reachability of destinations by sending them an ICMP echo request and waiting for a reply. Ping is used as a verb: "Ping the host to see if it is available"

**poll**

The act of instigating a return message from a set-top terminal.

**pooled set-top terminals**

set-top terminals that are considered to be assigned to all headend controllers in an office.

**post amplifier**

Output gain stage of an amplifier.

**power conditioner**

A passive or active electrical device that conditions the incoming line power, typically this unit will reduce or eliminate power anomalies such as sages, surges and short duration over voltage spikes.

**power divider**

A device used to divide received satellite signals.

**power doubling**

An amplification technique where two amplifying devices are operated parallel to gain an increase in output.

**power inserter**

A device used to couple power into antenna downlead to power LNB from a remote location.

**power supply**

As used in cable television systems, 1. A step down AC transformer that supplies low voltage AC (usually 60 volts) to operate amplifiers in the system, and 2. The module located in the amplifier housing that converts the low voltage AC to regulated DC for actual operation of the electronic devices inside the housing.

**premium channel**

A Static Channel offered as a supplement to basic Services (e.g. HBO, Cinemax). This Service is an additional fee to the Subscriber.

**premium service**

Continuous broadcasts as well as a-la-carte Events that are offered for a specific period of time, or programs sold off a Premium Service.

**Presentation Time-Stamp (PTS)**

A field that may be present in a PES packet header that indicates the time that a presentation unit is presented in the system target DCT.

**preview**

The time period at the beginning of an Event when promotional material can be shown on the same Channel as the Event, but unscrambled. Offices can determine whether to have Previews.

**processor**

Used to receive an off-air signal. The processor down converts the signal to an intermediate frequency, amplifies and upconverts to an output frequency.

**product ID**

A unique number assigned by NDTC to any entity that can be purchased through PPV. Examples include a product, a premium service, and possibly in the future, consumer goods, products sold on QVC

**Program Association Table (PAT)**

A table carried in the PID0 stream of transport multiplex that lists the service number of all services in the multiplex and indexes each number to a service control channel (SCC).

**Program Clock Reference (PCR)**

Represents the absolute time in 27 MHz clock cycles (ticks) of the 27 MHz clock that is defined to be the timebase for this service. The multiplexing process must correct any movement of the packet that contains the PCR from the absolute time with respect to the timebase that was used to set its value.

**Program Event Scheduler**

Allows users to send the events for particular services to the UCS. This program communicates with the AC database and UCS Maintenance to determine which services are available for the particular UCS.

**program map**

Same as service map. A data structure describing all the service components that make up a service, including the reference number (PID) of the packets that carry each components, and other related information. MPEG-2 uses "program" instead of "service" to describe this map, which is more typically defined for a series of programs.

**program map table**

A table that lists the PID numbers of data streams in a network service. This includes all elementary streams, the stream carrying the service's timing reference (called the PCR), and the stream carrying the service ECM messages. Each service in an HSTM has a SCC stream that carries the program map table; the service association table lists all SCC streams. An SSTM carries the program map table in the PID0 control stream.

**programmer**

A Programmer as defined for this specification is the entity that controls or manages the source of the video, audio or data that makes up a service.

**program-specific information**

Information provided with a specific service to support special user-interface features related to that service. PSI includes such information as tier level, purchasability, price, and rating code.

**proof-of-performance**

Evaluating the performance of an RF transmission system by measuring all parameters (i.e.-noise, frequency response, triple beat etc.). Test equipment is required to conduct these Proof of Performance studies.

**proprietary information**

Information that is the property of a given party or company and is not to be shared or disseminated to other parties or companies. Most commonly associated with technology, trade secrets, business plans, etc.

**protocol**

Formal specification of rules and conventions that governs how devices on a network exchange information; it defines format, timing, sequence, and error checking to be used.

**Protocol Data Unit (PDU)**

A general term for a message which is formatted specifically for a given protocol stack. This is often prefixed by T for Transport, S for Session, or A for Application.

**PSTN**

Public-Switched Telephone Network

**purchase unit**

GI's definition of the internal "price" per product stored in the set-top terminal. Used to establish and maintain credit limits.

**purge**

The process of removing Event information from the set-top terminals after an Event is over.

**Quadrature Amplitude Modulation (QAM)**

A data modulation technique used to convert digital program information for delivery in cable TV systems over in-band frequencies. A form of double-sideband modulation. The data stream is split into two half-rate streams. One of the data streams modulates a sine wave carrier, the other a cosine carrier at the same frequency. The resultant signal resembles a vestigial sideband signal with no pilot carrier present.

**Quadrature Phase Shift-Key (QPSK)**

A digital modulation method that combines two carriers that are 90 degrees out of phase (in quadrature), resulting in four possible phase states.

**QPSK Modulator**

Receives data from the IRT or DAC 6000 and multiplexes it with other OOB data. Outputs the multiplexed data onto the 75.25 MHz guard band.

**quantizer**

A component of a digital communications system whose function is to assign a discrete set of values to the amplitude of each successive sample of a signal.

**Quantum Reach (QR)**

A type of coaxial cable.

**quiet time**

The time when Event operations can be grouped and performed together during a less busy time period for the computers.

**Radio Frequency (RF)**

An electromagnetic spectrum above the audio and below the infrared frequencies, generally between 3 KHz and 300 GHz. It is the band of frequencies at which coherent electromagnetic radiation is possible

**Radio Frequency Interference (RFI)**

The introduction of electromagnetic radiation of radio frequency signals into operating circuits. RFI is also referred to as electromagnetic interference (EMI).

**radio service**

A stereo audio channel that is encrypted using a different encryption key than the stereo audio channel(s) associated with the video programming.

**randomization**

The method used to randomize the pattern of bits to ensure a properly shaped power spectral density.

**real-time**

An immediate (interactive) response; it does not involve a queue. RT puts messages and commands into the data stream with a Real Time reference. This is done for the 10-12 analog streams. RT was developed since the current Wagner HW for analog on Paris did not put out the right timing for the SDA box. The Real Time box resolves the timing and framing issues.

**redundancy**

Incorporation of duplicate components into a system so that a duplicate component immediately takes over if the primary component fails.

**Reed-Solomon encoder**

A block-based encoding technique used for FEC.

**Reiss Media**

A Broadcast Service Provider (Request Channel).

**reminder**

A DCT function that will remind the viewer in advance of a selected program.

**remote headend**

A secondary headend that is attached to a main headend via AML, fiber, or other connection.

**replaceable security**

Replaceable security refers to the ability to replace the DigiCipher II access control system. Encryption cannot be replace.

**retune event**

Defined as the successful tuning from one channel to another. A Pending retune event is defined as the retune information being present within the DCT 1000, an active countdown timer approaching the retune event, and the retune event time not yet occurred.

**return path**

The path from customers and subscribers via the INTS network through which impulse purchases and poll information is transported to the addressable controller.

**reverse cable tilt**

In short-spaced design applications; where the high frequencies are greater in amplitude than the low frequencies.

**RF channel**

The assigned frequency allocation for the transmission of information (video, audio, or data).

**RF filter**

Radio frequency filter that filters out low and high pass, notch and bandpass frequencies.

**RF scrambling**

A scrambling technology effectuated by suppressing elements of the signal's radio frequency. RF scrambling is generally not as secure as Baseband Scrambling is.

**riser**

Pole location in network where the cable plant alternately changes from underground to aerial.

**RMS Voltmeter**

Testing device capable of measuring true RMS voltage(s).

**roll-off frequency**

The frequency at which gradual or sharp change in gain versus frequency occurs. Found at either or both ends of the transmission bandpass.

**Rule of Frequency**

See *Cable Loss Ratio (CLR)*

**run-length coding**

After digital video is compressed with spatial and temporal techniques, the resulting data is examined for long strings of successive ones and zeros. The number of times a one or zero is repeated is counted, and then represented by a shorter code. This technique is run-length coding.

**SABRE**

SONET/ATM BiCMOS Receiver/Transmitter. A processor in the ITEM 1000 that detects SONET frames and delineates ATM cells carried in the frame payloads.

**sag allowance**

A percentage of fiber footage added to the design for future maintenance or emergency restoration issues.

**SAR processor**

Segmentation And Reassembly processor. A processor in the ITEM 1000 that reconstructs AAL5-CP protocol data units (PDUs) from ATM cell payloads and recovers MPEG packets from the PDU payloads.

**schedule**

This is a list of Events for which Devices will need to be authorized by the Event beginning and de-authorized after the Event end.

**schedule rule**

Rules that determine when the service is on or off for the channel.

**scheduling request**

A PPV participation request initiated by an Office.

**Scientific-Atlanta (SA)**

The manufacturer of one of two types of Controllers and set-top terminals used in the current TAC system.

**scramble**

Changing a signal so that it contains information, which allows only authorized set-top terminals to Descramble and view.

**semaphores**

A flag that prevents two or more processes from accessing the same resource at the same time. Semaphores will be used to control access to shared memory.

**Sequential Couleur Avec Memoire (SECAM)**

The television display technology that is standard in France, the countries of the former Soviet Union, and certain other countries. It is one of the three world TV standards, together with NTSC (United States) and PAL (Europe other than France).

**serial interface**

An interface or connection in which a serial (that is, bit-by-bit) communication protocol is used. Found on back of DCT and most personal computers.

**serial number**

A unique 10-digit number assigned to each terminal at the factory. It is programmed into non-volatile memory, making it available to the terminal's CPU. Its value is important during initialization, since the addressable controller uses it to assign a logical address to the terminal.

**serial transmission**

Transmission at successive intervals of signal elements constituting the same telegraph or data signal. The sequential elements may be transmitted with or without interruption, provided they are not transmitted simultaneously. The bit-by-bit transfer of data along a single path. This method is slower than parallel transmission, but is much cheaper when transmission is required over a distance.

**service association table**

A data structure describing the correspondence between a service and the PID value of the packets that carry the message stream that includes the service map.

**service components**

Any of the up to 8 components that comprise a digital signal. (Combination of audio, video, or text services.)

**Service Control Channel (SCC)**

The message stream that conveys the service map message and other service related information messages relating solely to a single service. The SCC is packetized and assigned a single PID; this is the PID value referenced in the Service Association Table.

**Service Handle**

A number assigned by the DAC 6000 to coordinate delivery of ECM messages to the ITEM 1000.

**Service Map**

A data structure describing all the service components that make up a service, including the reference number (PID) of the packets that carry each component, and other related information.

**Service Number**

An MPEG number used to identify video services provided by the cable system. Currently this field has a range of 1-8192. A number assigned to each service in a transport multiplex (SSTM or HSTM) to identify the collection of data streams that make up the service and distinguish it from other services. Within an HSTM, each service number must be unique.

**Service Providers**

Same as Broadcast Service Providers and Outside Service Providers (see Broadcast Service Providers).

**Service Units**

A unit used by the set-top terminal to store the value of a Product.

**set-top terminal**

A digital Terminal or analog Device that the Subscriber uses to receive programming on a cable system. It is the last Device used before the Product is consumed.

**set-top terminal address**

An address that identifies a set-top terminal.

**shared memory**

The same memory segment is mapped into the address space of two or more processes

**shared services**

Allows different programs to run on the same Channel for a pre-determined time, on a Schedule created by the requester.

**shielding**

The outer conductor of the coaxial cable.

**signal**

A visible, audible, or other conveyor of information; the embodiment of electrical impulses being transmitted.

**signal leakage**

Undesired emission of signals out of a CATV system. Usually through cracks in the cable, corrosion or loose connections.

**signal level**

Amplitude of signal voltage measured across 75 ohms, usually expressed in decibel millivolts.

**signal-to-noise ratio (S/N)**

The ratio of signal power to noise power at some point in a circuit, often expressed in decibels (dB). A measurement widely used to judge the quality of a received signal. For example, the analog television picture reception is said to be "snowy" when the S/N is low. The relative power of the signal to the noise in a channel, usually measured in decibels.

**signature**

Peak/Valley response of an amplifier type.

**Simple Network Management Protocol (SNMP)**

Standardized method of managing and monitoring network devices on TCP/IP-based internets.

**sinewave**

A waveform with deviation that can be expressed as the sine and cosine of a linear function of time or space or both.

**Single Service Transport Multiplex (SSTM)**

A self-defining, MPEG-2 compliant, packet-based digital data stream composed of multiple component streams. Component streams include one or more elementary streams plus a PID0 control stream.

**skin effect**

When Alternating Current (AC) flows through a metallic conductor more electrons will flow through the conductor in the area near the outer surface of the conductor than will flow through the center of the conductor.

**sleep timer**

A programmable timer that can be set to automatically turn the DCT "on" or "off."

**SONET**

Synchronous Optical Network - High-speed, synchronous network designed to run on fiber at digital transmission rates from 51.84 Mbps to beyond 2.4 Gbps (gigabits per second).

**spectrum**

In telecommunications, a specified range of electromagnetic frequencies or, in some cases, the whole range of frequencies considered to constitute electromagnetic signals.

**spectrum allocation**

A Federal Communications Commission allocation, or setting aside, of portions of the available electromagnetic spectrum for specific purposes, such as for personal communication service.

**spectrum analyzer**

Equipment that automatically scans through a selected frequency spectrum and displays input signals on a chart of amplitude versus frequency.

**splitter**

Equipment used to divide a signal into two or more identical, lower power signals.

**stacked antenna array**

A group of identical antennas physically grouped and electrically connected for greater gain and directivity.

**standby generator**

A fuel-power (for example, gasoline, propane, diesel) generator used to back up electrical power in the event of an electrical power failure.

**standby mode**

The mode that a GI Encoder should be in if there is no Event. No scrambling or control.

**standby power supply**

A step down alternating current (AC) transformer that converts 120 volts AC to a lower AC voltage (30 or 60 volts) to be carried on the coaxial cable along with the cable signals to power active devices in the distribution plant. In addition, batteries and an inverter are included to provide backup power in the event of an electrical power (120 volts AC) failure.

**Start-Time Order**

An ordering of NVOD movies wherein each movie appears in a list starting from the next closest start time and continuing in the order of start times as far into the future as is required. Depending on how far into the future this list is prepared, many of the movies may appear multiple times.

**start-up phase**

The period of time during which a new NVOD movie is introduced into the system. At the beginning of this time period, only one playback machine starts to deliver video. Subsequently, at the beginning of each new show channel increment, a new machine starts to deliver video. At the end of the startup time, the last machine assigned to the movie begins to deliver video.

**static service**

Continuous subscription service.

**status monitoring**

A method of monitoring or alternately testing system parameters. P.C. based system that communicates with transponders.

**store-and-forward**

set-top terminals store authorized Subscriber purchase(s) and forwards the information to the main Headend or Data Collector when requested.

**stream**

A "stream" of data is a continuous receipt of packets that have an identical packet ID. Packets are guaranteed to arrive in order, but their locations can move somewhat through the multiplexing process. This movement represents packet location jitter. A packet stream carries one "service component".

**Subscriber Authorization System**

A system that controls authorization of set-top terminals for selected services. Includes both national and local control.

**subscriber ID**

An identification number stored in the Business System and ACC 4000D that identifies the subscriber.

**surge**

A transient wave of current, potential, or power in an electrical circuit.

**surge arrester**

A protective device for limiting surge voltages in equipment by discharging or bypassing surge current. prevents continued flow of current to ground and is capable of repeating these functions as specified. Synonymous with Lightning Arrester.

**surge protector**

A protective device, consisting of one or more surge arresters, a mounting assembly, optional fuses and short circuiting devices, etc., which is used for limiting surge voltages on electrical and electronic equipment or circuits.

**Sybase**

The relational SQL database used within the DAC 4000 to maintain information on set-top terminals, subscribers, pay services, etc.

**symbolic rate**

A measurement of digital transmission speed. In telephone modems, referred to as Baud Rate.

**synchronous**

The term synchronous refers to the instantaneous alignment of two or more events in time. Events may occur at irregular intervals, though at the same instant and still be synchronous. Using this definition, "synchronous data" only implies that the data and the clock occur at the same instant, not that the clock is regular.

**Synchronous Transport Signal (STS)**

The logical signal specification for SONET frame structure. This specifies electrical transmission rates based on 51.84 Mbps (STS-1). OC-3 is 155.52 Mbps.

**Synchronous Video Randon Access Memory (SVRAM)**

SVRAM combines SDRAM and serial access memory using synchronous operations to improve VRAM total performance. SVRAM has a block write mode and write-per-bit capability

**T Carrier**

There is a hierarchy of T carrier systems, which were designed to transmit digital voice signals but now also handles data transmission. In North America, the designations (T-1, T-3, etc.) correspond to the designations for the digital signal hierarchy:

T-1 = DS-1, 1.544 Mbps, 24 voice channels

T-1c = 3.152, Mbps, 48 voice channels

T-2 = DS-2, 6.312 Mbps. 96 voice channels

T-3 = DS-3, 44.736 Mbps, 672 voice channels

T-4 = DS-4, 274.176 Mbps, 4,032 voice channels

T-1 uses two pairs of twisted pair copper and is used to connect networks across distances. T-3 runs on fiber optic cable and is often called FT-3. T-4 can operate on coaxial cable, microwave, and fiber optics.

**tags**

A number inserted on the audio while modifying the vertical and horizontal pulses on the video by a pulse waveform. If the set-top terminal has this tag number in its authorization mask, the Service is Descrambled (see also Event Tag Number). Analog tags range from 1-253, while digital Tags range from 1-XX.

**tasks**

Individual procedures stored in the database that run at specific times, based on the start and end times of an Event, to prepare for the Event and “clean up” after the Event is over.

**TAXI**

Transparent Asynchronous Xmit/Receive Interface. A clock-encoded serial data format that uses two signals: data and strobe.

**TCP/IP**

Transmission Control Protocol / Internet Protocol allows sharing of applications among computers in a high-speed environment; corresponding to the transport and network layers of the OSI model.

**Telco**

The collection of purchase information via telephone line.

**telephony**

Use or operation of an apparatus for transmission of sounds between widely removed points with or without connecting wires.

**teletext**

Equipment used to generate textual information for broadcast.

**Television Receive Only (TVRO)**

Associated with the type of antenna used to receive the satellite assigned.

**Telnet**

A terminal emulation program for TCP/IP networks such as the Internet. The Telnet program runs on your computer and connects your PC to a server on the network. You can then enter commands through the Telnet program and they will be executed as if you were entering them directly on the server console.

**temperature compensation**

A method of maintaining system levels that fluctuate due to changes in cable attenuation with temperature.

**terminal device**

This is a digital device that the subscriber uses to receive programming on a cable system. It is the last device used before the product is consumed. The preferred term is set-top terminal.

**terminal multiplexer**

Generates SONET signals from multiplexed Asynchronous signals

**terminator**

A resistive load for an open coaxial line used to eliminate reflections and to terminate a line in its impedance.

**thermal noise**

Caused by the random activity of electrons within metal. The equivalent theoretical standard is -59.2 dBmV for a 4 MHz Channel.

**thermal pads**

An attenuator that varies its loss dependent upon temperature.

**tier**

Refers to the level of services offered to subscribers by the Cable System, such as Basic or Extended Basic.

**tilt**

The frequency vs. gain characteristics of amplifiers and other devices. Amplifiers most often have a higher gain at higher frequencies to offset the greater attenuation of cable at higher frequencies. The different in the amplifier gain at the highest system frequency and the lowest system frequency is the tilt.

**time base**

The starting point of a schedule day. Varies by Service Provider.

**Time Division Multiple Access (TDMA)**

This involves the use of a single frequency/space slot by further dividing time into slots and allocating those time slots to multiple users. Works by assigning each caller a unique timeslot and then sends packets of data during that slot versus CDMA and FDMA. (CED 4/94)

**time-out counter**

The number of hours that a set-top terminal can operate without receiving the control data channel information. Once this time is reached, the set-top terminal shuts down.

**timed viewing**

The ability of a customer to purchase programming for a selected time period only.

**token ring**

As defined in IEEE 802.5, a communications method that uses a token to control accesses to the LAN. The difference between a token bus and a Token Ring is that a Token Ring LAN does not use a master controller to control the token. Instead, each computer knows the address of the computer that should receive the token next. When a computer with the token has nothing to transmit, it passes the token to the next computer in line.

**traffic system**

An automated system that handles all areas of a service's business functions: sales, spot placement, billing, historical reporting, etc. Examples include Columbine, Enterprise, and Savant.

**transaction number**

A unique identifier used to track a requests as they pass through the NDTC AC System.

**transceiver**

A terminal that can both transmit and receive data.

**transcoder**

A device that converts data between two different coding formats.

**transducer**

A device that converts energy from one form to another.

**transient suppression**

The process of guarding against damage to electronic equipment or circuits caused by high voltage or current transients.

**transmission**

The sending of information (signals) from one point to another.

**transmission channel**

The transmission channel is the physical link layer defined in the ISO network model that is used to carry the data link layer. For example, the satellite signal path and cable signal paths are transmission channels. MPEG-2 transport is a data link layer that is carried on this physical medium. FDDI, SONET and DS3 are all other examples of a transmission channel.

**transmitter**

Equipment used to generate, amplify, modulate and radiate an RF carrier signal into space.

**transponder**

The part of a satellite that receives and transmits a signal. A particular frequency on a particular satellite relay device which receives a signal from a ground station, amplifies the signal then broadcasts the signal at a different frequency back to earth.

**transport**

Transport is the carriage of data from one point to another using a specific protocol. In the DigiCable System the transport protocol is packet based.

**transport multiplex (transport stream)**

A collection of transport packetized components whose data represent a single service or multiple services, arranged as a multiplex and defined by a single service association table.

**TSODA**

Transport Sync OSD (On-Screen Display) DES (Data Encryption Standard) Audio. The TSODA is an element that provides the system security handling. This security functionality exists on the encoder and key server as Encryption Engine Element (EEE), on the IRT as TSODA, and on the set-top terminal as Access Control Element (ACE) The hardware is the same in all places, but the firmware changes. As the security element, the TSODA provides the encryption/decryption in all of the indicated devices. The TSODA function on the IRT is to encrypt and decrypt the packets--encrypt services on the satellite side and decrypt services on the cable side.

**Trellis**

A type of coding used with digital modulation that allows errors to be detected and corrected at the receiver.

**triple beat**

An unwanted distortion component caused by the third order, non-linear transfer characteristics of transistors and other active devices. Triple beat distortion is composed of the sum and difference distortion products

**trunk or express cable**

The main distribution lines leading from the headend to various areas where feeder lines are attached to distribute signals to subscribers.

**turnaround**

A service provider uplinked and downlinked at NDTC without further NDTC intervention.

**TVPassCard**

Technology for enhanced management and decryption of services.

**two-way**

A Return Path is used. It can be upstream RF on cable of via the public switched telephone network.

**UCS maintenance**

The Forte based Uplink Control System Maintenance program allows a user to dictate such details as the encoder names, active TSPs (Television Service Providers), defined services and attributes.

**Ultra High Frequency (UHF)**

Corresponding to electromagnetic signals in the range from 300 to 3000 MHz; channels 14-69 are commonly referred to as UHF channels on the television dial.

**UMS Server**

The Uplink Manager System Server controls the interface/messages between different programs and the UCS. When a user is logged into the Uplink Control System (UCS), no one else is able to communicate with that UCS.

**Uninterruptible Power Supply (UPS)**

A backup power supply that, if activated, provides continuation of power without interruption.

**unity gain**

When the gain of an amplifier equals the loss of the cable preceding it.

**UNIX**

Operating system, originally designed by AT&T, used for communicating, multi-user, 32-bit minicomputers. It has become widely accepted because of its versatility.

**Unshielded Twisted Pair (UTP)**

Cabling that does not require the fixed spacing between connections that is necessary with coaxial-type connections; used for rates between 1 and 4 Mbps.

**upconverter**

Shifts the IF signal to a usable transmission frequency.

**uplink**

Earth to satellite transmission. The transmission of a signal from its earth station source up to a satellite in orbit. The opposite of downlink, which goes from orbit to earth.

**Uplink Control System (UCS)**

A VAX-based system created by GI to control encoders for DigiCipher II. The UCS is the actual system, which controls the encoders and the services on them. However in the HITS design, this is done by sending the UCS messages via the UMS. Using such programs as UCS Maintenance, Program Event Scheduler (PES), Encoder Management System (EMS) and Authorization Station (AS), a user can control everything on the UCS without being physically logged on.

**Uplink Facility**

Transmits program information up to a geosynchronous satellite.

**Uplink Management System (UMS)**

Automated system that coordinates playback of video, audio, and digital service; disperses the scheduled services to other control mediums necessary to access the system.

**upstream**

Upstream as it applies to cable systems includes all signal flow from set-top terminal units back to cable headends.

**User Datagram Protocol (UDP)**

A transmission protocol that uses an IP address to identify the destination host and a port number to identify the destination application.

**Velocity of Propagation (VOP)**

Velocity of signal transmission along a coaxial cable relative to the speed of light in free space.

**Very High Frequency (VHF)**

Corresponding to electromagnetic signals in the range from 30 to 300 MHz.

**video band**

The frequency band utilized to transmit a composite video signal (4.2 MHz).

**Video On-Demand (VOD)**

Video delivered immediately when requested by customers. Usually refers to pre-recorded movies or information.

**video signals**

30 Hz to 4.2 MHz Includes color, luminance, vertical and horizontal information.

**video units**

A contiguous finite time segment that a set-top terminal may be authorized to view and/or that must be controlled separately. Examples of Video Units within an Event are: 1. The Preview period; 2. The purchasability period; and 3. The period after the Preview and purchasability periods (which may overlap) to the end of the Event.

**virtual channel**

The ability to dynamically build a Channel at uplink through the UMS. Through the set-top terminal, the Subscriber is provided transparent switching of digital Services, creating a desired collection of programming for purchase.

**Virtual Channel Indicator (VCI)**

Identifies a service. This value is embedded in the SONET/ATM optical input to the ITEM. The ITEM uses this value to rebuild an SSTM from the optical input. This value, along with the Virtual Path Indicator (VPI), identifies an ATM connection.

**virtual channel map**

A data structure describing a service, or a subset of a service, usually meaningful to a user, and a reference number called the virtual channel number (VCN).

**virtual channel mapping**

New channel map that is downloaded by the headend.

**virtual fast forward**

Offered in conjunction with NVOD, the ability to "fast-forward" and resume viewing. Resumption of viewing is achieved by the DCT automatically switching to a channel with a later start time.

**Virtual Path Indicator (VPI)**

Identifies a service provider. This value is embedded in the SONET/ATM optical input to the ITEM. The ITEM currently ignores this value. This value, along with the Virtual Channel Indicator (VCI), identifies an ATM connection.

**virtual pause**

Offered in conjunction with NVOD, the ability to "pause" and resume viewing at a later time. Resumption of viewing is achieved by the DCT automatically switching to a channel with a later start time.

**virtual rewind**

Offered in conjunction with NVOD, the ability to "rewind" and resume viewing. Resumption of viewing is achieved by the DCT automatically switching to a channel with an earlier start time.

**Viterbi decoder**

A decoder in the signal receiving equipment (in this case, the digital terminal) that decodes 4/5 convolutionally encoded data.

**voltage regulation**

A voltage sensitive device that automatically initiates a corrective change in its output voltage to provide a constant voltage to provide a constant voltage to a circuit.

**walk-out information**

Information gathered preceding a system design strand distance verification, natural and man made obstacles, M.D.V's etc.

**waveform**

The characteristic shape of a signal, usually displayed as a plot of amplitude over a period of time.

**wavelength**

Distance between two points of corresponding phase in consecutive cycles in a periodic wave.

**Weatherstar**

A device used by the local operator to interface local weather information and data into the modulator of the National Weather Channel.

**WireLink**

A protocol/command set defined by General Instrument Inc. for communications between customer billing systems and addressable controllers.